POPULAR SCIENCE

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OUR WARPLANES GROW STRONGER

PG. 82

A MIGHTY LITTLE GUN PROTECTS YOUR HOME

PAGE 101

How to make your

FLASHLIGHTS and BATTERIES LAST LONGER

These Wartime Suggestions have been Reviewed and Passed by the Office of Price Administration and the Office of Civilian Defense

1 DON'T USE FLASHLIGHT CONTINUOUSLY. Snap it on when you *need* to see—then snap it off. *Needless* use of flashlight merely wastes "juice."

2 WHEN STARTING A TRIP, don't toss your flashlight *loaded* into your suitcase, haversack or toolbox. Unscrew, or remove batteries—then switch can't "catch" and waste batteries.

3 KEEP FLASHLIGHT OUT OF CHILDREN'S REACH. It is not a toy—but a tool for your convenience and safety. *Know* where it is at all times—so you can put your hand on it quickly when you *need* it.

4 DON'T THROW AWAY A BROKEN FLASHLIGHT until you're sure it can't be fixed. Minor repairs can quickly be made, lens or bulb may be replaced.

5 DON'T "HOARD" BATTERIES—keep one extra set for each flashlight in case of long-continued use. Others want and need batteries too. *Do your share* in conserving the nation's battery supply.

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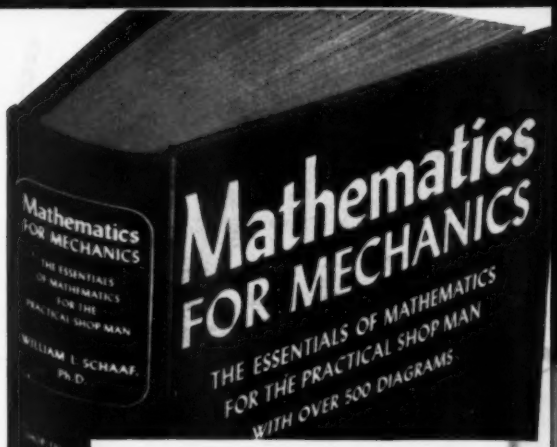
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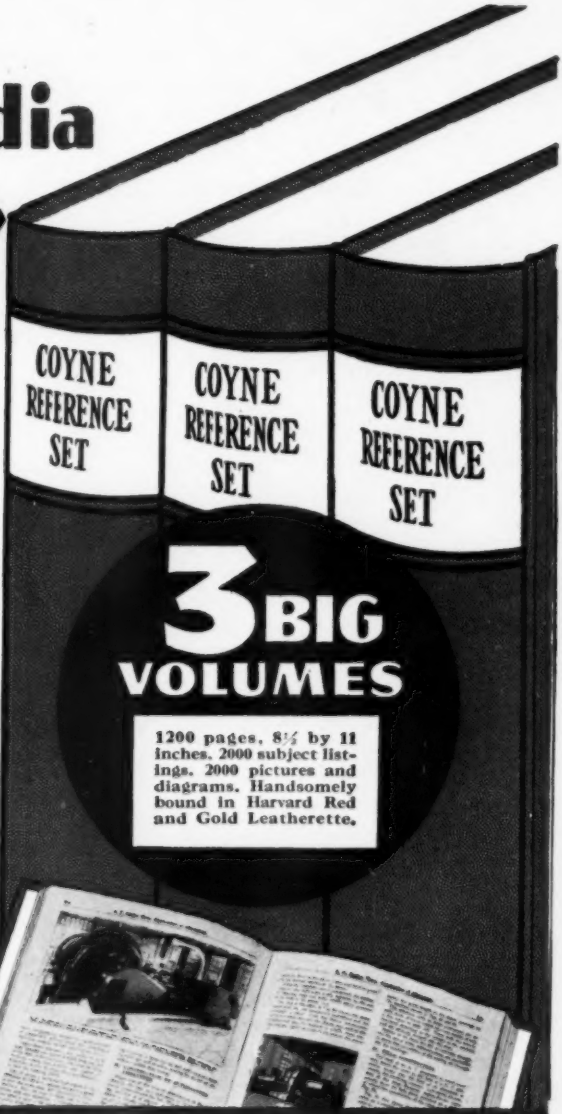
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Mechanics & Handicraft

A TECHNICAL JOURNAL OF SCIENCE AND INDUSTRY

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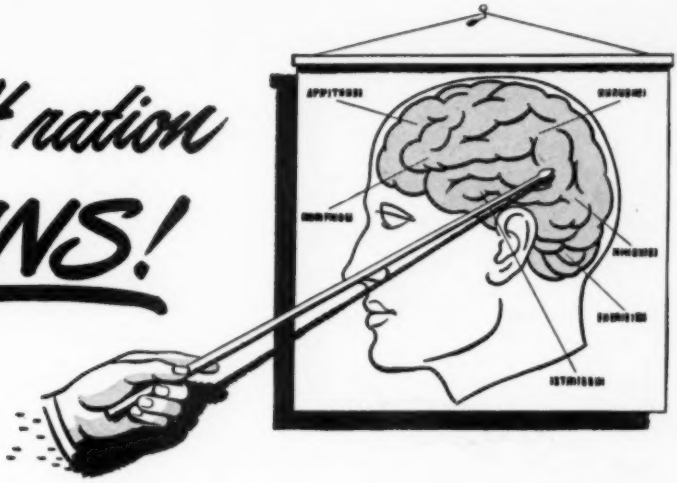

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MAIL THE COUPON. I'll send you the FREE Lesson and my big, interesting book. They'll tell you about my Course, how I train you, what others have done, the types of jobs open to trained Radio Technicians. You'll read letters from more than 100 men I trained. You'll see what Radio offers YOU. And you'll have my FREE Lesson to keep, **without obligation.** No salesman will call. Mail the Coupon NOW—get started today on the road to bigger pay!

J. E. SMITH, Pres., National Radio Institute
Dept. 2KP3, Washington, D. C.

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By the time you've conducted 60 sets of Experiments with Radio Parts I supply —have made hundreds of measurements and adjustments—you'll have valuable PRACTICAL experience.

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CHAMPION SPARK PLUGS

Cargo ships of the highways, the transport trucks of this nation, are actively in the service of their country 24-hours a day, 7 days a week. Thus they play their vital, indispensable part equally with the trucks that transport troops and munitions of the armed forces. Unfailing dependability is the watchword of both, and in this service Champion Spark Plugs are maintaining their reputation for the unfailing ignition which has made "*Champion*" and "*dependable*" synonymous.

Champion's patented Sillment seal is but one of many exclusive features which make them equal to any emergency. This compressed dry powder seal permanently banishes troublesome gas or compression leakage *common to ordinary spark plugs*—which causes them to overheat, pre-ignite and results in rough, wasteful engine operation. You can depend on Champion Spark Plugs in every engine in any emergency.

More Vital - More Dependable than ever!

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

TO SAVE GASOLINE • KEEP YOUR SPARK PLUGS CLEAN

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Model Builders Attention!

	V	V-2	V-3
Hex	½"	⅜"	5/16"
Thread	3/8"-24	¼"-32	¼"-32
Thread Length	7/32	7/32	5/32
Weight, Grams	8	3½	2½

Actual Size V-Plug

Champion spark plugs for model gas engines give the same dependable performance as regular Champions. Sillment sealed. Sillimanite insulator. Alloy needlepoint electrodes for easy starting. One piece construction.

CHAMPION

SPARK PLUG COMPANY • TOLEDO, OHIO

THE MEN and the planes of the Army Air Forces carry a mighty responsibility. Victory or defeat—freedom or slavery—can depend on the strength of our air squadrons and *the skill of the crews who keep them in fighting trim.*

Today one of the most pressing needs of the Army Air Forces is for men, 18 to 45, *who can handle tools* — men with experience as automobile, truck or tractor mechanics, radio operators or repairmen, sheet metal workers, welders, service repairmen, or related skills.

If you have experience or training in any of these fields *you can now enlist directly in the Air Forces.* Here you'll have a chance to work with the finest equipment, on the newest and fastest planes, preparing yourself for a career in the limitless future of aviation. You'll get the world's best training—at good pay. And you'll be in line for rapid promotion. A man who rises to Master Sergeant in his first enlistment receives $138 a month, with board, housing, uniforms and medical care free, plus additional allowances if married.

This is your opportunity to serve your country where you're needed most. Sooner or later you'll say, "It's up to me." Why not NOW?

The nearest Army Recruiting and Induction Station will gladly give you full details, without obligation.

U. S. ARMY "KEEP 'EM FLYING!"

RECRUITING AND INDUCTION SERVICE

• *Visit or write the nearest U. S. Army Recruiting Station or write to: "The Commanding General," of the Service Command nearest you.*

Or write to:
Enlisted Branch, Dept. Z-1, A.G.O., Washington, D. C.

Do Unseen Powers Direct Our Lives?

ARE the tales of strange human powers false? Can the mysterious feats performed by the mystics of the Orient be explained away as only illusions? Is there an intangible bond with the universe beyond which draws mankind on? Does a mighty Cosmic intelligence from the reaches of space ebb and flow through the deep recesses of the mind, forming a river of wisdom which can carry men and women to the heights of personal achievement?

Have You Had These Experiences?

. . . . . that unmistakable feeling that you have taken the wrong course of action, that you have violated some inner, unexpressed, better judgment. The sudden realization that the silent whisperings of self are cautioning you to keep your own counsel—not to speak words on the tip of your tongue in the presence of another. That something which pushes you forward when you hesitate, or restrains you when you are apt to make a wrong move.

These urges are the subtle *influence* which when understood and directed has made thousands of men and women masters of their lives. There IS a source of intelligence within you as natural as your senses of sight and hearing, and more dependable, which you are NOT using now! Challenge this statement! Dare the Rosicrucians to reveal the functions of this Cosmic mind and its great possibilities to you.

Let This Free Book Explain

Take this infinite power into your partnership. You can use it in a rational and practical way without interference with your religious beliefs or personal affairs. The Rosicrucians, a world-wide philosophical movement, *invite* you to use the coupon below, now, today, and obtain a free copy of the fascinating book, "The Mastery of Life," which explains further.

USE THIS COUPON

Scribe E.J.W.
The Rosicrucians, AMORC, San Jose, California.

I am sincerely interested in knowing more about this unseen, vital power which can be used in acquiring the fullness and happiness of life. Please send me, without cost, the book, "The Mastery of Life," which tells how to receive this information.

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(AMORC)

(The Rosicrucians are NOT a religious organization.)

Behind Your Back--

WHAT IS SHE CALLING YOU—

HE-MAN or Weakling?

Charles Atlas

An actual untouched photo of "The World's Most Perfectly-Developed Man."

BELIEVE it or not—the girls are sizing you up *all day long!* Whether they look at you TWICE is up to YOU! They *will* if you have a rugged, healthy, big-muscled HE-MAN body, glowing with strength and vigor, but they'll just snicker at you behind your back if you're a skinny, no-muscle WEAKLING! If YOU, too, want to feel those admiring glances right through your back then listen to this:

Let Me Prove I Can Make YOU a NEW MAN— Charles Atlas

Will you give me just 15 minutes a day of your spare time? That's all I need to PROVE—regardless of how old or young you are, or how ashamed you may be of your present physique—that I can give you a body men envy and women admire. Biceps that can dish it out, and a muscle-ridged stomach that can take it. A full, deep barrel-chest. Legs that never tire. A tough, sinewy back. An all-around physique that can laugh at ANY kind of rough going.

We're ALL in the Army today! The heavy war-time demands on strength and endurance are no longer limited to front-line trenches. It's only a matter of time until EVERY citizen is called to shoulder his full share of the load. ALREADY the Army has enrolled men from 18 to 64. And whether you do your part in Uncle Sam's Services or as a home-front civilian, you've GOT to be in 100% SHAPE. Every man, young or old, owes it to himself to get a body with the bulldog staying power that double shifts of working call for. HOW DO **YOU** STACK UP?

Would You Believe I Was Once a 97-lb. Weakling?

Yes, I **was**—a miserable 97-pound bag of skin and bones. But you'd never believe it to look at me now, would you? Through my discovery of **"Dynamic Tension"** I changed myself into "The World's Most Perfectly-Developed Man." I'm LIVING PROOF of the miracles **"Dynamic Tension"** can perform—right in the privacy of your own home! NOW—will you give my method 15 minutes a day to get the kind of HE-MAN build you have always longed to have?

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I want the proof that your system of "Dynamic Tension" will help make a New Man of me—give me a healthy, husky body and big muscular development. Send me your free book, **"Everlasting Health and Strength."**

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(Please print or write plainly)

Address.....

City.....State.....

From the News Editor's Desk

MILLIONS OF KILOWATT HOURS of electrical energy are being salvaged monthly as a by-product of the testing of airplane engines. Every power plant is test-run for about 12 hours before being installed in a plane, both to break it in and to reveal any mechanical flaws. In the past, this has been done by attaching a special propeller and letting the engine churn the air while burning up large quantities of high-octane gasoline. Now an alternating-current generator is attached as load and its output is pumped into the factory's power system.

WAS THERE A LAND BRIDGE between the Americas during the Ice Age? Scientists will have to wait until the end of the war to settle that question. A large collection of fossils gathered in Honduras by an expedition of the Field Museum of Natural Science may hold the key to the mystery, but on account of shipping conditions and U-boat activities they must remain in storage in that country for the duration. So a puzzle of the past must wait while the future of the world is being decided.

ALL-OUT WAR EFFORT BY COWS, to increase milk production for supplying our allies, may be promoted by administering chemical hormones. Research in England has shown that stilbestrol, a sex hormone made in the laboratory, and anterior pituitary extract, a glandular substance obtained from the ox, both stimulate the flow of milk even in virgin animals. In one experiment, a scrub goatling which had never given birth was brought into lactation by merely rubbing the udder with an ointment of stilbestrol.

CELLOPHANE IS 50 YEARS OLD. History of the ubiquitous transparent wrapping material goes back to the fundamental laboratory work of two English chemists, Charles F. Cross and Edward J. Bevan, half a century ago. A Swiss, Jacques E. Brandenberger, developed and commercialized the material, and perfected his production machinery by 1912. He also gave it its name, coining the word from the first syllable of "cellulose" and a Greek word meaning glasslike or transparent.

NATURE PROVIDES THE CAMOUFLAGE for Camp Murphy, new training center for Signal Corps radiomen, on the edge of the Florida Everglades near Hobe Sound. Instead of being arranged symmetrically in a clearing, the green-painted camp buildings are scattered higgledy-piggledy over a nine-mile-long reservation among dense subtropical trees and shrubs. It's a town planner's nightmare—but it would also be a headache to any enemy bombardier who tried to spot it from the air.

AUTO-LITE SPARK PLUGS

"GOSH, WILLIE — SINCE WE GIVE THE OLD CAR THET 'PLUG-CHEK' ONCLE RAFE AIN'T MISSED A ONE!"

HOW "PLUG-CHEK" HELPS PEP-UP SLUGGISH, GAS-WASTING ENGINES

Yes, the Mountain Boys know what to do when cars are hard to start, sluggish on the road. It's time for "Plug-Chek" —the new inspection service offered exclusively by Auto-Lite Spark Plug Dealers. "Plug-Chek" helps spot gas and power-wasting plugs—and shows what to do about it. Simply cleaning and regapping your present plugs may cut dollars off your gas bills. Stop for a "Plug-Chek" today.

Color and condition tell if plugs are operating properly. Matching your plugs with those illustrated on the "Plug-Chek" is the first step in getting new life for spark-weary engines.

THE ELECTRIC AUTO-LITE COMPANY
Toledo, Ohio · *Merchandising Division* · Sarnia, Ont.

In its 26 Great Manufacturing Divisions, Auto-Lite is Producing for America's Armed Forces on Land, Sea and in the Air

Readers Say:

That Japanese "Mystery Sub" Was No Mystery to P.S.M.

WHILE looking through the July 1934 issue of POPULAR SCIENCE Monthly, I was astonished to see a photograph of the "mystery" Japanese two-man submarine. At the time the Japs employed this type of submarine against our Navy at Pearl Harbor, our newspapers carried the story that this undersea craft was something entirely new in naval warfare. It is interesting to note this "scoop" by seven years of P.S.M.—Pvt. A. B., Camp Kilmer, N. J.

Veteran Sailmaker Recalls Work on Cup Defenders

AS A sailmaker, I read with much interest the article "Sail Making" in your August issue. Without taking the least glory from my good friend George Ratsey, I feel that it is only fair to correct the statement that Ratsey and Lapthorn had equipped every defender for the America's Cup for the last 83 years. I was connected with the Herreshoff Company (who built every defender from 1892 to 1930) for 38 years and worked on the *Defender, Columbia, Constitution, Reliance,* and *Resolute* (defender). I don't remember when the Ratsey sail loft was established at City Island, but am quite certain that the sails for the *Reliance* and those defenders previous to her were all made by the Herreshoff Mfg. Co., with Asa Hathaway foreman. From my records I know that the *Reliance* had the largest mainsail ever made and required 1,810 yards of 22-inch duck to make, and that when the races had been concluded we had made 65 sails of all sizes and weights, and five of these were mainsails. You can readily see that this biggest mainsail took over a mile of canvas and weighed when completed approximately 1¼ tons.—W. P. P., Bristol, R. I.

He Found Only 1,968 Triangles in That Diagram of P.M.C.'s

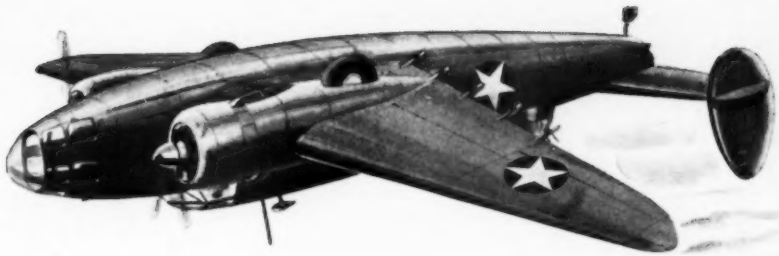
P. M. C., of Dubuque, Iowa, wrote that he found 500,000 possible triangles in his diagram. He should have said 500,000 *impossible* triangles, because I found only 1,968 different triangles. P. M. C. requested the solution from the master minds of Readers Say. I do not consider myself a master mind, but I thoroughly disagree with *his* solution unless he counted each triangle 200 times. How about some answers from other readers? I think your magazine is swell. Keep up the good work.—A. B., Springfield, Mass.

Ink Blots Were Just Fun Before the Psychiatrists

IN THOSE dear, dead days beyond recall, back in the Gay Nineties, before psychiatrists, psychopaths, and psychoanalysis were ever heard of, ink-blot pictures were a popular parlor pastime, known as magic portraits. The paper was folded to form a line on which one wrote his name with a coarse pen and plenty of ink. Then, in refolding the paper, pressure was applied outward from the fold and up and down along the fold. Some very grotesque figures resulted, but no one tried to diagnose neurotic or psychotic conditions from them and determine whether the subject was fitted for this or that job. It was just fun and helped to pass a pleasant evening. By the way, are not psychiatrists in the same class with astrologers and palm readers?—E. S. T., Bristol, Pa.

He Sharpens His Razor Blades in an Ordinary Glass Tumbler

IN Readers Say I saw mention of a hone for safety-razor blades, and I wish to say that an ordinary glass tumbler will do just as well. Put the blade inside with a drop of water and rub it around with the fingers. After 100 strokes the blade will be as sharp as a new one.—F. F. N., South Orange, N. J.



Upside down or right side up . . .

at 20° below or 100° above

Without electricity, no modern bomber could ever leave the ground.

Electricity starts the motors, retracts the landing gear, changes the propeller pitch, works the wing flaps, opens the bomb doors, powers the radio and inter-communication system, operates the instruments, gives light for the crew to work by.

No ordinary electrical apparatus can handle these jobs in a bomber.

The whole complicated system must work as well upside down as right side up. It must function in a tropical thunderstorm and in 20° below zero altitudes. And it must be designed to save every precious fraction of an ounce and inch.

Developing electrical equipment for bombers—and producing that equipment in quantity—is a job made to order for Westinghouse "know how."

Here are some of the Westinghouse products that are going into American bombers today:

- **Instruments designed so one instrument does the work of two.**
- **Radio equipment and special blind-flying devices.**
- **Electric motors that develop more horsepower per pound than any other motors ever built.**
- **Instrument lights that cast invisible rays on dial markings.**
- **Electric generators which weigh only 42 pounds, yet produce as much electricity as 35 standard automobile generators weighing 23 pounds each.**

In making these things, the long-range work of Westinghouse Research and Engineering Laboratories has played a significant part. Discoveries in many fields—in electronics, physics, chemistry, mechanical and electrical engineering—are now bearing fruit in the production of better and more powerful weapons of war.

Many of these discoveries, we believe, will someday help to make a better peacetime world.

★ ★ ★

This advertisement has been reviewed by Government authorities, and contains no information of military value to the enemy.

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Present Position.....

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Readers Say:

Suggests Protective Coloring for Military Planes

THERE are quite a number of military planes that pass over our place. I can always see them very plainly because they are so dark. I would think that if this were enemy territory these planes could be spotted very easily. Why doesn't the Army paint them sky-blue on the under surfaces and dark on top? Then the enemy could not see them so easily from either above or below. I have enjoyed your magazine for many years.—G. M., Lincoln, Mo.

Put Two Auto Ideas Together To Make Speed Warning Light

IN YOUR July issue you showed how to put a light in your car to indicate when the choke was on. Then, in your August issue, you showed how to put spring tension on the accelerator to indicate when you were going over 40 miles per hour. I put both of your suggestions together. I mounted a stop-light switch near my carburetor and mounted a red light on my dashboard. I connected the switch to the foot accelerator. By careful adjusting, the red light comes on when I reach the speed of 40 m.p.h. I feel that the red light is more noticeable than the spring tension. I hope other readers may find this idea useful.—G. S. R., Piedmont, Ohio.

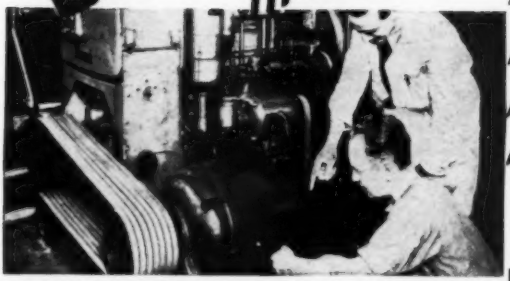
Plastic Laboratory "Glassware" Not So Hot, This Reader Says

IN ANSWER to the brainstorm of V. H. Y., Geneva, Ill.: Plastic laboratory apparatus might be all right for some things, but suppose you wanted to work with a liquid that dissolves the plastic. Suppose the plastic melts upon heating. Such things have to be considered. I'll stick to glassware; then the only chemical I have to be afraid of is hydrofluoric acid. Glass can be heated to redness, too, without much damage. As for its being dangerous, it is much safer to have a test tube drop on the floor than to have it dissolve in your hand. I suggest that V. H. Y. try using rosin on his fingers; it may help.—R. P., North Andover, Mass.

Be an ENGINE TECHNICIAN!

many good jobs await you in:

- DIESEL,
- GASOLINE ENGINES,
- MECHANICAL SERVICING,
- ENGINE RE-MANUFACTURE



Take your place as an Engine Technician in America's Victory Program NOW;—also be ready for continued advancement in industrial rebuilding when the War is over.

SHOP METHOD HOME TRAINING

BRINGS YOU RICH OPPORTUNITIES TO EARN MORE MONEY

"TRAINED MEN NEEDED," cry the Want Ad Columns of every newspaper, in every city. That's proof of the need today! And after the war, too, Trained Technicians will continue to be in demand, with permanent jobs, for the vital work of industrial reconstruction. National Schools now offers YOU a new opportunity to train *quickly* right in your own home, for these better jobs, in the active Diesel, Gasoline Engines, Mechanical Servicing and Engine Re-manufacturing fields. Trained Engine Technicians are needed in the Army, Navy, Civilian war production plants, Government Shipyards, in Industrial Engine Re-manufacturing, and many other similar spots—and will be so needed for years to come.

MEN SUBJECT TO MILITARY SERVICE AIDED

National Schools' Diesel and Mechanical Training helps men get extra rank, extra pay, in war service, to repair tanks, tractors, road equipment, generating sets; also in Diesel Motor Marine operations. Many service men have enrolled.

NATIONAL GRADUATES SUCCEED

INCREASES PAY

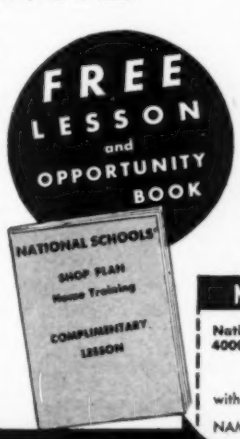
"I am happy to say I have been able to earn more than $200 a month; National training helped me."
H. A. LONG,
Spencer, N. C.

DIESEL EXPERT

"It's a pleasure to express my appreciation for training I received at National. I am now with Coast Guard as Diesel Expert."
WILLIAM BLISS,
U. S. Coast Guard,
Massachusetts

RUNS BIG DIESELS

"Am employed in operation of two 2500 h. p. Diesel engines at Standard Oil Co."
RONALD DUNN,
New Jersey



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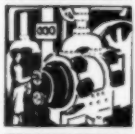

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Dodge	Plymouth
Ford	Pontiac
Graham	Reo
Hudson	Studebaker
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And major data needed to service 405 models of trucks

Nearly 200,000 Vital Facts on Every Phase of Tune-Up and Repair • Over 450 Charts, Tables • More than 900 Photos, Drawings, Diagrams • Over 600 Big Pages—Size 8¼x11 inches.

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Rush me MoToR's 1942 Factory Shop Manual. If O. K. I will remit $1 plus 35c shipping charge in 7 days, and $1 monthly for 4 months. ($5.35 in all.) Otherwise I will return book in 7 days. (Foreign price $6, cash with order.)

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Readers Say:

And Thank You, W.C.—But Once a Month Is Enough

I HAVE been thinking of writing you for a long time to speak my piece about your magazine. I am an enthusiastic reader of P. S. M. and like it *very* much. I think it is the best magazine on the market today. Every article is interesting, and although I do not have a workshop I enjoy the articles describing various projects nearly as much as the others. I am a chemistry fan, and the articles on that subject by Kenneth M. Swezey especially appeal to me. I am like another of your readers: why don't you make P. S. M. a semimonthly or weekly magazine? I don't get any enjoyment out of waiting a whole month between issues, because they are so very instructive and interesting. Keep up the articles about chemistry and physics, add more, and keep up the other good work of your fine magazine. I get lots for my money out of it. Thanks a million!—W. C., New Hampton, Mo.

Chicken Raiser Speaks Up for Steel from Tin Cans

You told B. B. that he would not have to worry much longer about what to do with old tin cans. Here is another angle of the tin-can question: After the tin is taken off, cannot the base metal be melted down and rerolled into a cheap grade of metal for general use? Wood is getting scarcer every day, and a cheap metal would be fine for many kinds of construction work. I have been making a hobby of growing chicks, and rats take a great toll of them. Metal coops are ratproof, light in weight, rainproof, and otherwise desirable, but they have now been taken off the market. Metal salvaged from tin cans might be used in making such coops, or in ratproof wire which would provide safe runs for the little chicks.—E. P. C., Nitta Yuma, Miss.

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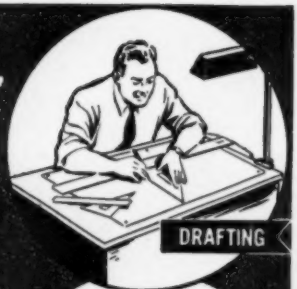

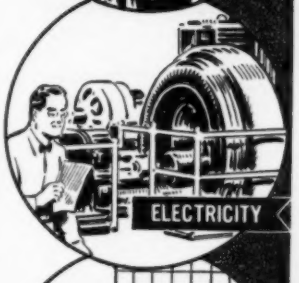

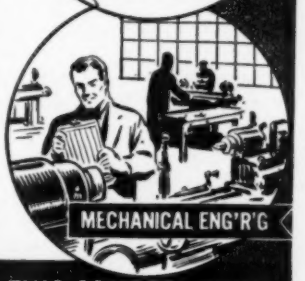

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WHEN Uncle Jed whittled out "Jake the drake" back in '88, he didn't know he was carving a "statue of liberty." Yet that is just what he was doing. For this battered old decoy symbolizes every American's right to enjoy the unrestricted privilege of hunting . . . a freedom that aided in the exploration and development of our country.

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WHEN THE WAR IS OVER, all the wealth and effort that we have poured into the struggle will not have been shot away and destroyed. There will remain a backlog of expanded manufacturing facilities, new scientific discoveries, and improved methods that will make life better for all. That's the message of an article that will encourage you about the future.

BLOCKS OF GLASS that float like cork are now being used for heat insulation in the food industry. Literally a hardened foam of regular glass, the new material can be worked with carpenters' tools and is proof against moisture, fire, and vermin. Its lightness may even make it a substitute for cork and other buoyant materials. Read about the amazing performances and promising future of this product.

TWO GUNS IN ONE: that's the U. S. Army's 105-mm. howitzer. Used as a regular rifle, it is more mobile and twice as powerful as the World War 75; as a howitzer, it lobs mashie shots high in the air to fall vertically on enemy troops sheltered (as they think) on the reverse slope of a hill. You'd better read up on this versatile weapon; it's going to be in the news.

A STEEL RULE is one of the most important tools in the machinist's kit—and if he doesn't know how to use it accurately, his skill with other tools won't do him much good. An article based on a Government training film tells how to employ the various kinds of steel rules, and their companion tools such as calipers and dividers, in translating drawings into work.

CUBIC INCHES of cargo space will be among the decisive factors in winning the war. To make room for more war materials on every ship that floats for the United Nations, the Army's Services of Supply is revamping its methods of packing supplies. So successful has it been that for every ten ships launched, an eleventh and perhaps a twelfth is created in effect—a phantom fleet fighting for victory.

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FOREWORD—William B. Stout

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IX Principles of Aircraft Engines
X Aeronautical Meteorology
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I Aeronautical Nomenclature
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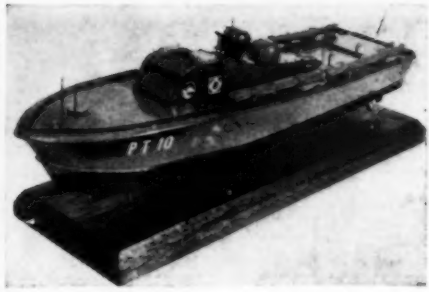

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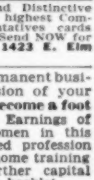

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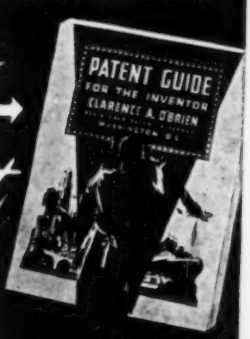

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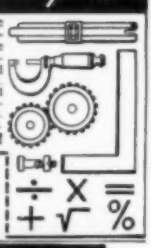

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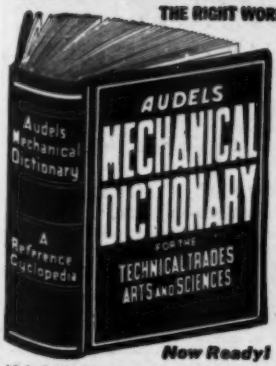

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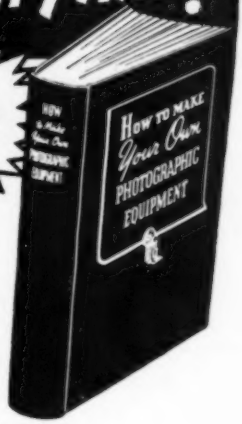

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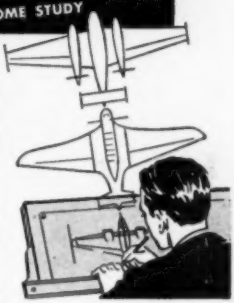

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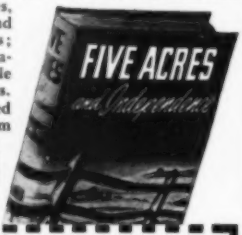

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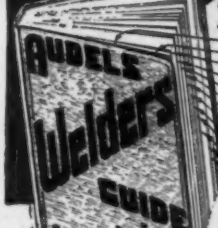

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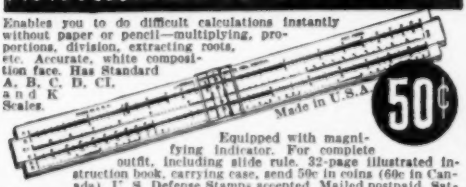

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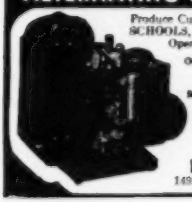

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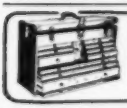

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WHAT DO YOU MEAN, ALADDIN AND HIS LAMP?
A BATTERY OF THESE LITTLE DEVICES CREATE AN ENORMOUS WALL OF SMOKE TO SCREEN TROOP MOVEMENTS
THAT SCREEN CAN TRIPLE THE ATTACK EFFECTIVENESS OF A REGIMENT
IS THE SMOKE IN THOSE GRAY CONTAINERS NOW?
NO— BUT THE SMOKE-PRODUCING CHEMICALS ARE
I'VE ALWAYS FELT THAT THE BEST SMOKE COMES OUT OF A HANDY RED POCKET CAN
HA! HA! THAT'S RIGHT— PRINCE ALBERT SMOKES ARE THE MILDEST YET THE MOST FRAGRANT I KNOW
NOW HE'S REMOVING THE SAFETY PINS FROM THE SHELLS. ALL THE GUNS ARE ELECTRICALLY CONTROLLED
WOULDN'T THE ENEMY BE WARNED BY THE SMOKE THAT AN ATTACK WAS COMING?
OF COURSE— BUT THEY WOULDN'T KNOW ON WHAT SPOT TO TRAIN THEIR GUNS. THAT'S THE POINT IN LAYING A SMOKE-SCREEN
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Another First for the Electron Microscope

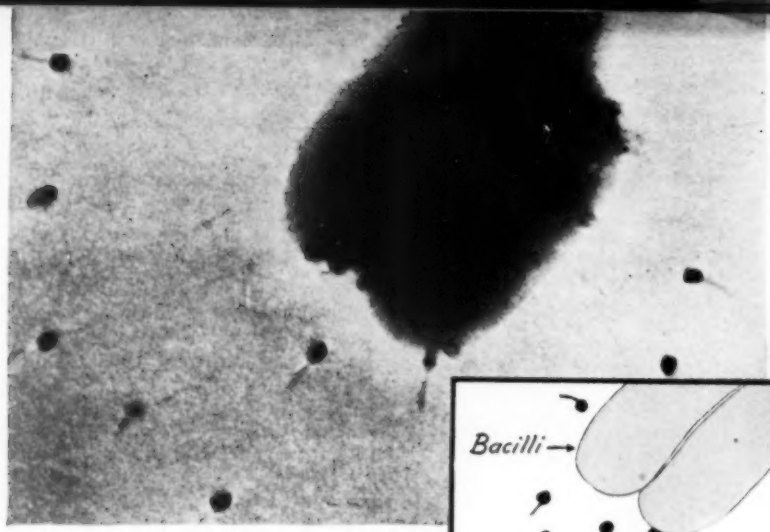
FIRST PORTRAIT OF A BACTERIOPHAGE

Five of the germ-killing viruses, magnified 60,000 times in this remarkable picture, reveal their strange tadpole-like shape. Such views promise giant strides in the conquest of disease through preventive medicine

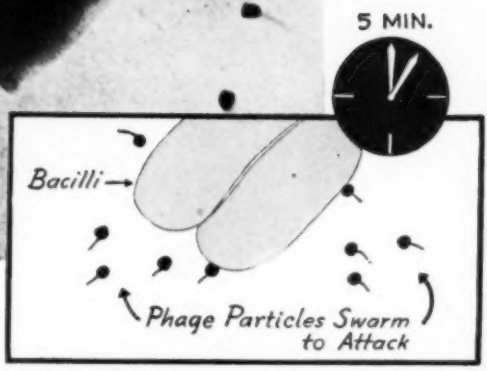
HOW friendly, tadpole-shaped viruses help sick people get well has just been revealed to the eye and the camera. Collectively, they are called "bacteriophage," which medical men have theorized about but never before have seen in action. Now the RCA electron microscope, 50 times as powerful as the best optical instrument, portrays for the first time dramatic scenes of phage particles in victorious combat with germs.

White blood corpuscles, antibodies, and bacteriophage form the body's triple alliance against dangerous bacteria. Comparative giants in size, the germ-eating white corpuscles are easily observed. But it was hardly more than a year ago that observers at the electron microscope sighted antibodies, which behave as if they were chemical molecules, coating and immobilizing germs without destroying them. In contrast, the filterable viruses of bacteriophage now have been seen to attack and demolish germs. Whether they are living organisms or chemical bodies still is a moot question among scientists.

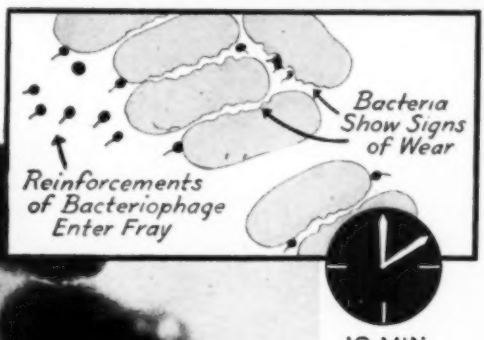
Bacteriophage pictures show that the viruses measure only about 1,000 atoms long and 600 atoms wide. A thousand of them could parade single file into a pinhole through this paper before the first one reached the other side. Yet they fearlessly prey upon bacteria many times their size. Attaching themselves to a germ by head or tail, they multiply rapidly, and in about 30 minutes the unhappy host is done for. Dif-

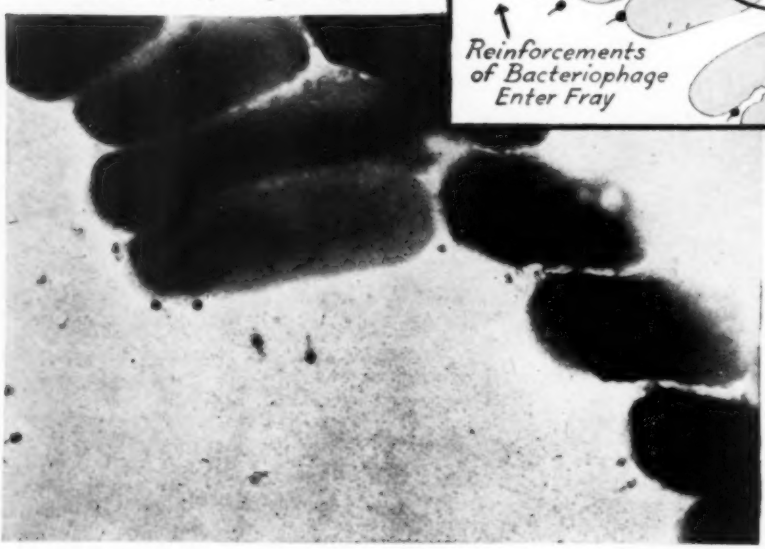


Bacteriophage attacking bacteria (Bacillus coli). As shown here, magnified about 34,000 times, they have had only about five minutes since being mixed with the germs



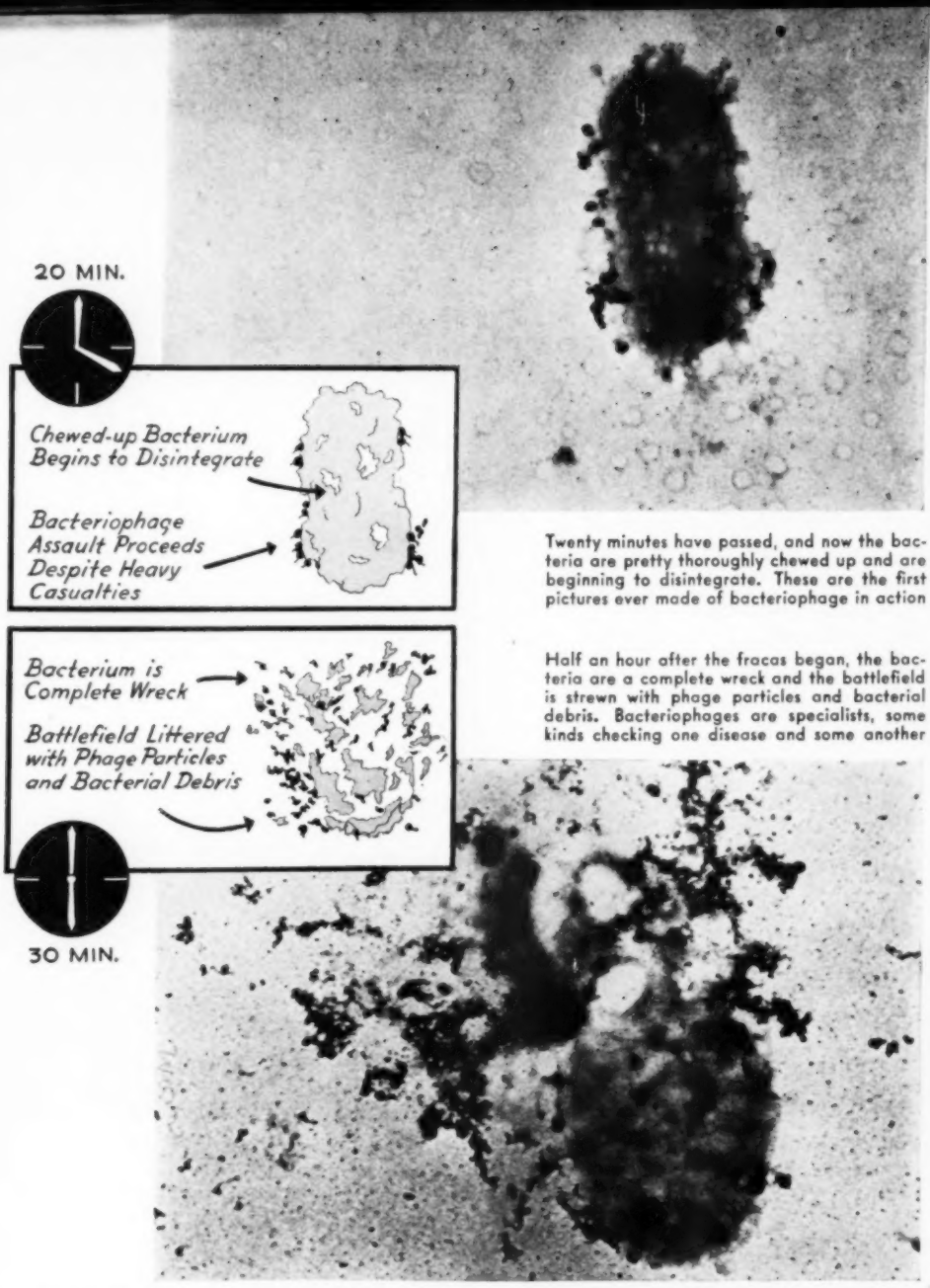
After ten minutes, reinforcements come up to help the bacteriophage, and the bacteria show signs of wear. In this and the photomicrographs on the opposite page the RCA electron microscope magnifies 20,000 times





ferent types of bacteriophage have finicky tastes, selectively attacking germs of specific diseases.

To observe it under the electron microscope, separate cultures of bacteriophage and germs are mixed upon a supporting film of the specimen holder. After five, 10, or more minutes the mixture is dried, stopping all further interaction, and permitting observation of what has happened in the given time. First experiments by Dr. S. E. Luria, of Columbia University's College of Physicians and Surgeons, and by Dr. Thomas A. Anderson, of the RCA Research Laboratories at Camden, N. J., employed the germ called Bacillus coli—a favorite "guinea pig"


20 MIN.
Chewed-up Bacterium Begins to Disintegrate
Bacteriophage Assault Proceeds Despite Heavy Casualties
Bacterium is Complete Wreck
Battlefield Littered with Phage Particles and Bacterial Debris
30 MIN.

Twenty minutes have passed, and now the bacteria are pretty thoroughly chewed up and are beginning to disintegrate. These are the first pictures ever made of bacteriophage in action

Half an hour after the fracas began, the bacteria are a complete wreck and the battlefield is strewn with phage particles and bacterial debris. Bacteriophages are specialists, some kinds checking one disease and some another

among bacteriologists because of its typical behavior. Further tests with disease germs confirmed the results. Different kinds of bacteriophage were seen to vary somewhat in their proportions, but those observed possessed characteristic "heads" and "tails."

Implications of the new means of studying germ fighters stagger the imagination. Hitherto medical experts have had to grope in the dark, hampered by conflicting theories, developing new ways of immunization against disease by slow and cautious experiment. Able at last to see and study what they have theorized about, they foresee phenomenal advances in preventive and curative medicine.

Intrusion Tactics

LIKE UNINVITED GUESTS AT A PARTY, THE HAVOCS RUIN THE NAZIS' SHOW

IT IS night over a German airport. Droning high in the darkness, out of the flak range of air-base defenses, and painted black as death, is a wicked, American-built light bomber which the British call the Havoc or the Boston, and Americans call the DB-7 or the Army A-20.

The Havoc (let's stick to the British name since this is a British operation) is waiting, motors throttled, for the return of Nazi bombers from a visit to England. Here they come now. Their crews are tired from dodging flak over England. Now that they are almost home their alertness slips from them; their taut nerves relax.

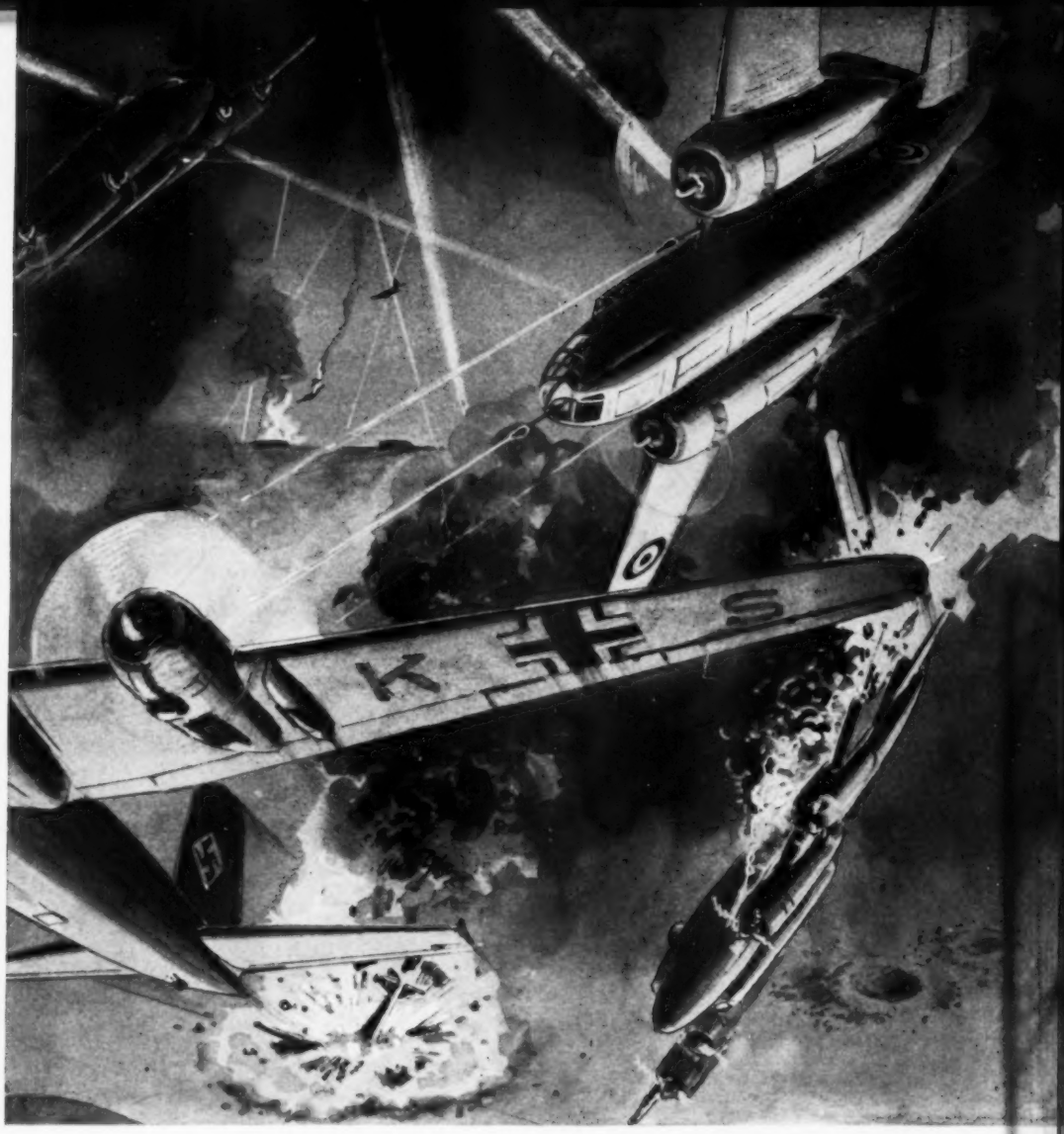
From above the Havoc drops on them like an avenging falcon, its cannon and machine guns blasting viciously. The German pilot can't do much maneuvering. He is short of fuel from his trip to England and back. If his plane is not shot down, he tries to land so hurriedly that he forgets to lower his wheels, or overshoots his mark, and crashes in the darkness. The bombardier in the Havoc adds to the general chaos by bombing out the field lights of the German base.

Perhaps the German gives his motors the gun and tries to make a run for it to another field. The Havoc lets him go. For there is a Havoc hovering over every field the bomber can make with the limited fuel left from the round trip to England, and the bomber is merely postponing the bad news, not escaping it.

Intrusion tactics are the name given to this type of operation, for the Havocs intrude themselves over the German air bases like unwelcome guests at a party, unwelcome guests who eat up all the cake and have all the fun. In fact, party terminology was used by one pilot in describing what goes on. "Just a piece of cake," he said. "We shoot at everything we see, frequently getting two or three. The Jerries sometimes get so jumpy they start firing at each other."

The American A-20's, originally built for the United States Army Air Forces as light attack bombers, have been found perfect for intrusion tactics. It is a shoulder-wing, all-metal monoplane, powered by two Wright

These American-built British-piloted Havocs . . .



. . . hover over German bases at night and destroy returning bombers whose crews and fuel are spent

Cyclone engines, which are placed in underslung nacelles, tapering back far beyond the trailing edge of the wings.

The planes carry a crew of three or four and are equipped with heavy armament, light bomb load, and exhaust screens. For night-intrusion operations the planes are painted a dull black. The pilot's single cockpit is forward of the propellers and the bombardier's transparent compartment is in the nose. The gunner can fire from a rear cockpit, or from an opening in the belly of the ship.

The Havoc has one outstanding peculiarity of construction. Its wings are pointed downward, instead of up. In order to get it into the air, when roaring down a runway, the pilot has to pull the stick back to lower the tail and offset the tendency of the nose to press down. The British ordered quantities of the planes in the early days of the war and used them as attack bombers under the name of Bostons. When the Germans shifted bombing attacks from day to night, after they lost the Battle of Britain, the Bostons were equipped as night fighters and called Havocs. It is a singularly appropriate name.

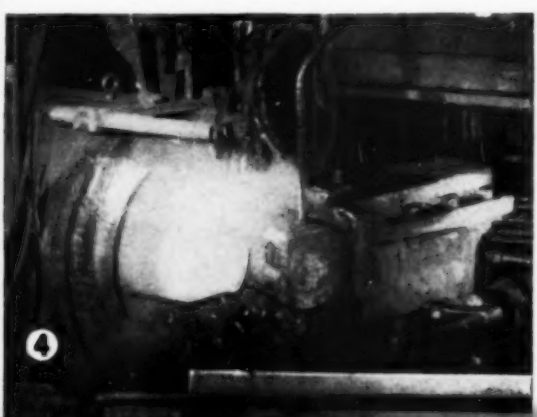
1 Clamped in the hollow spindle of a spinning machine, the heated end of a seamless steel tube is rotated against an electrically heated roll while a steel tool molds the white-hot metal. Each spinning machine is manned by a three-man crew

Spinning Big Bombs the

2 In a few seconds, the bomb's nose begins to take form, the movable tool being manipulated by the operator so that the hot metal is molded toward the tube's center. In half a minute the nose of the bomb is formed and closed by a perfect weld

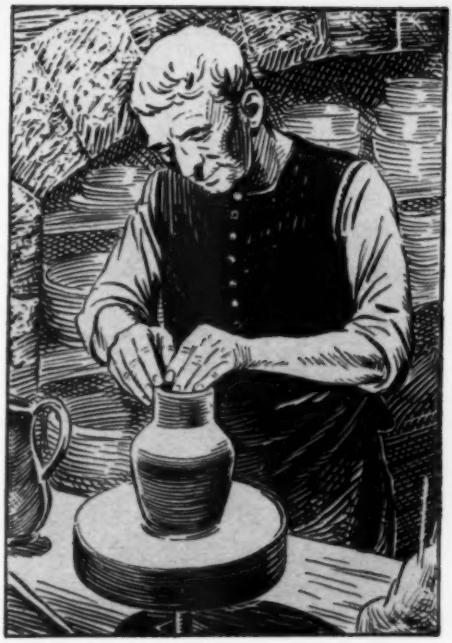
3 After the nose has been spun, a conveyor takes the bomb casing to another furnace, in which the other end of the tube is heated as shown in the photograph. A 36-inch length of eight-inch tubing, for example, makes the case for a 100-pound bomb

4 On another spinning machine, the shaping of the bomb's tail is started. This is done in the same manner as the shaping of the nose except that the end is left open for loading. Then lugs are welded onto the casing to fit plane bomb-suspension devices



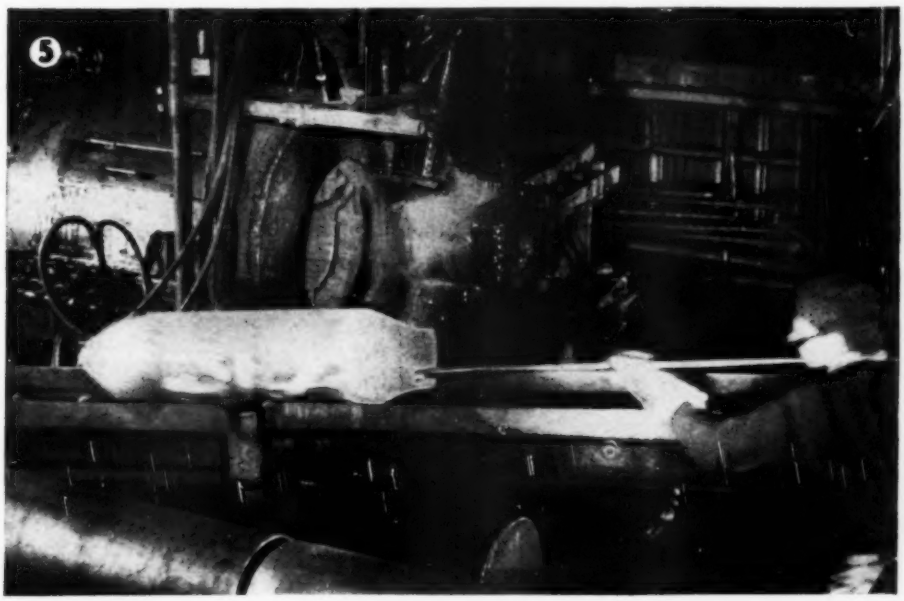
LIKE moist clay taking shape under skilled fingers on a potter's wheel, tubes of white-hot seamless steel, with the uniform strength of solid forgings, are now spun into casings for aerial bombs. Devised by engineers of a U. S. Steel Corporation subsidiary, this revolutionary process is turning out thousands of bombs in plants in the Pittsburgh area, and its originators are teaching their competitors how to use it.

A few of the men who operate the spinning machines are old hands in the steel mills, but most of them are youngsters who have been trained during the past two years. In teaching the process, teamwork is emphasized, and in organizing the three-man crews great care is taken to select men who will work well together. Each crew sticks to its own machine, and thinks it is the best in the plant. The process is much faster than the old way of making bomb casings, which was to shape a slab of steel in a cupping press, stretch it into a closed end cylinder by repeated drawings, and machine its nose to a point.



Way a Potter Spins a Vase

5 A conveyor carries the shaped casing to a normalizing oven where it is treated to toughen the steel. It is then air-blasted inside and out with pieces of steel. Nose and tail are machined and drilled for fuse and fin assembly. After spraying and lacquering, it is oven-dried ready for shipment



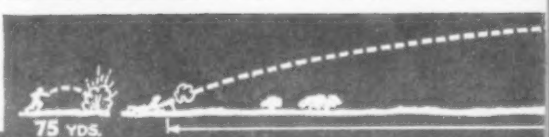
AMERICA'S VEST-POCKET CANNON IS A Machine-Gun Destroyer

ACCURATE 60-MM. MORTAR THROWS DEADLY SHELLS INTO THE ENEMY'S LINES

By HICKMAN POWELL

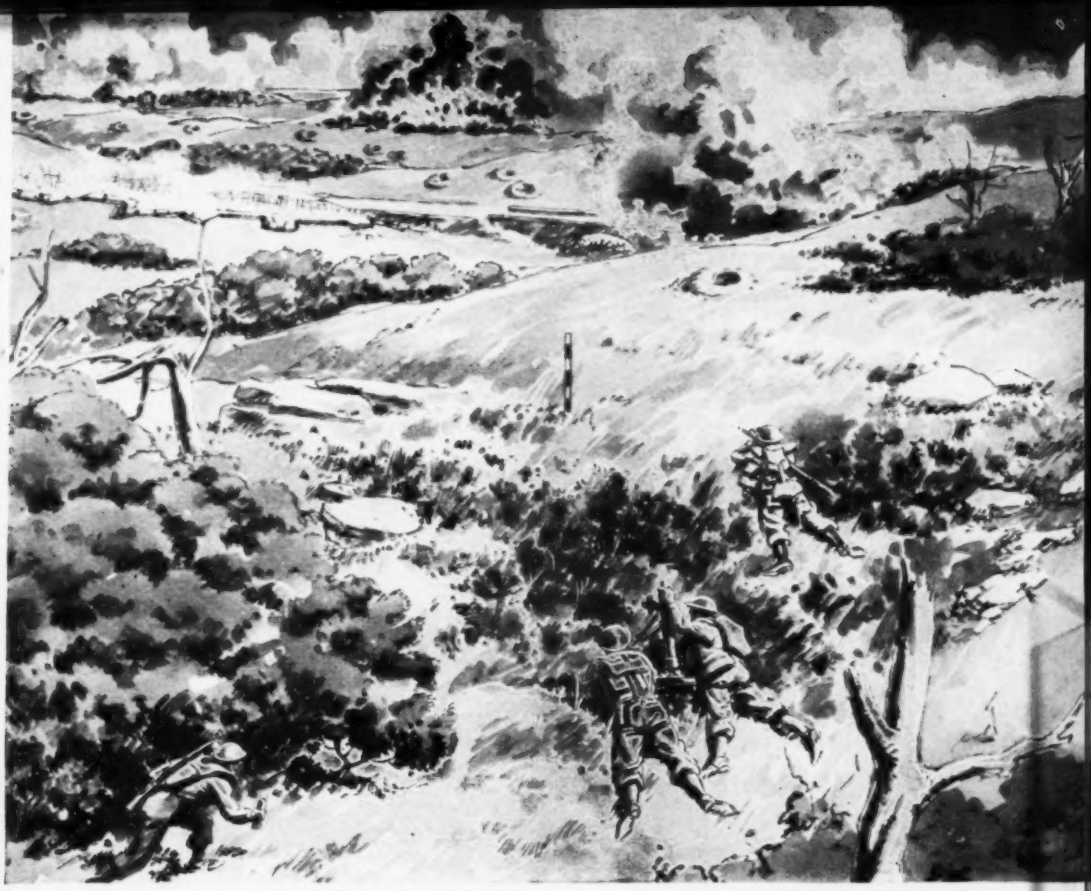
ONE of the most important elements in the increased fire power which our infantry uses against the Axis is the 60-millimeter mortar, a light, hand-carried cannon which tosses three-pound packages of TNT with deadly accuracy at ranges up to 2,000 yards.

Along with the machine-gunners in the weapons platoon of an infantry company, there are mortar squads of five men, each equipped to do a clean-up job on enemy troops whom rifles and machine guns cannot reach—men who have taken cover in ravines or trenches, along the banks of streams, in woods, or on reverse slopes. The mortar projectile flies high into the air



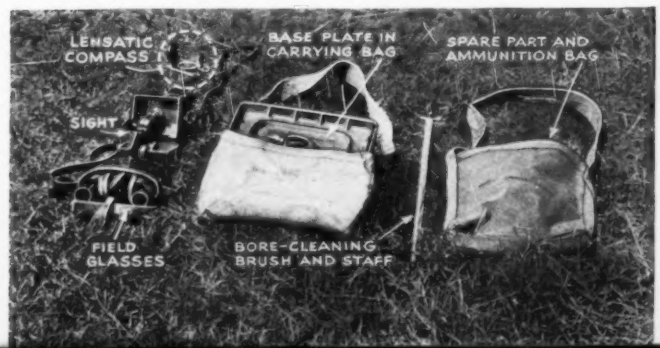
COMBAT TEAMS are five-man squads, each carrying a complete gun and equipment and 36 rounds of ammunition. Additional ammunition is brought up to the lines in quantity by the Army's versatile quarter-ton trucks

HEADING EACH SQUAD is a corporal. Shoulder pads ease the load of his equipment, which is shown at the right



Even the best of grenadiers can throw a hand grenade no farther than 75 yards, while the new 60-mm. mortar is effective at that range and up to 2,000 yards. The diagrams above illustrate this difference. In the drawing at top, the powerful little mortar is shown tossing destructive shells over obstacles into the enemy's lines

THE CORPORAL carries field glasses, the sight, lensatic compass, mortar base plate, a bore-cleaning brush and staff, and a bag of spare parts, as shown below from left to right. The gunner in the photo at the right carries the mortar tube and a bipod on which it rests. He bears side arms for protection in the event the squad is rushed by the enemy during close fighting



GOING INTO BATTLE, the corporal leads the squad, followed closely by the gunner and ammunition bearers. He moves up ahead to spot the enemy position, carrying with him an aiming stake on which the gunner, back in a protected depression, as below, trains his sights

ATTACHING THE BASE PLATE. The end of the mortar is set on the plate, as above, and held with a lug. The base is fixed in position before the crew goes into action

and drops almost vertically on its target.

This weapon is a simple but ingenious thing calculated to delight anybody who ever enjoyed playing with fireworks. It is simply a smooth-bore pipe, about 2 1/3 inches in caliber and about 29 inches long, and has a cap screwed on the base end. There is a firing pin in the center of this cap, and the mortar is fired simply by dropping the projectile tail first into the muzzle of the steeply elevated barrel. The impact on the firing pin, as it slides down the barrel, detonates the propelling charge. Lying beside it, a gunner can fire in this fashion at the rate of 35 shots to the minute.

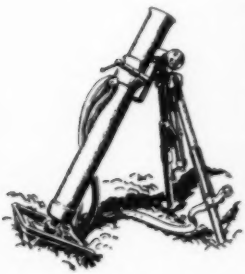
The base of the barrel ends in a spherical projection, which locks into a socket on a steel base plate which rests on the ground to take the recoil. The tube is supported on a bipod which incorporates traverse and elevating mechanisms. The whole thing weighs only 42 pounds and is easily taken apart for carrying.

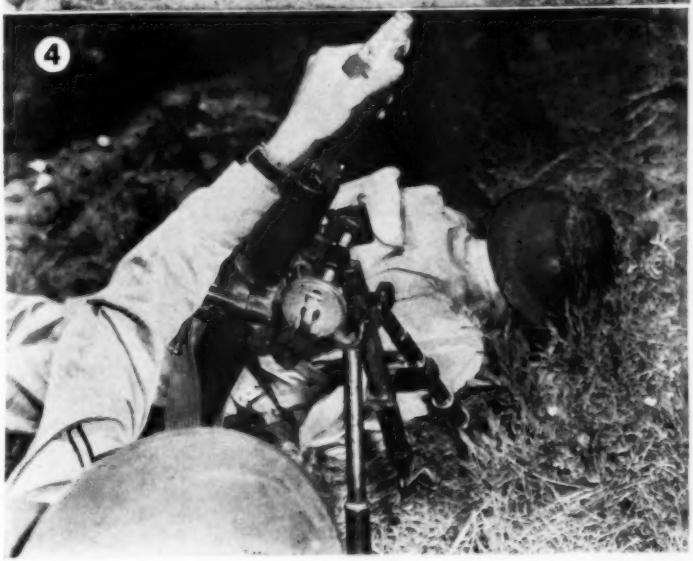
This mortar itself is not fundamentally very different from the Stokes mortar used in the First World War. The big difference is that the 60-millimeter job is a high precision instrument finely made and the ammunition has been developed to a high point of accuracy and safety. The Stokes mortar shell was shaped like an elongated tin can, and it had no fins. Thrown from a low-velocity tube, it tumbled end over end in flight. It was of short range and a hit was largely a matter of luck. Sometimes, too, the old Stokes exploded prematurely, killing its crew.

Today's mortar missile flies true to its

BURSTS OF THE SHELLS are kept in view by the corporal as he shouts back directions for aiming. Only a few of the first shots go wide, for he is a trained judge of distances

AIMING THE GUN. Using the sight and aiming stake, the gunner adjusts the mortar until the squad's leader gives the word that the range has been found. His job is done for the moment now; he lies to one side as an assistant gunner takes over





FIRING IS DONE simply by dropping shells tail first into the muzzle of the mortar. Impact of the shell as it strikes the firing pin detonates the propelling charge. An assistant gunner lying down can fire 35 shots a minute

target. Painted bright yellow, with black markings (bright blue for practice shells), it is also a very pretty plaything. A round of ammunition for the 60-millimeter mortar is about 9½ inches long, tapering at both ends, with eight fins on its tail to make it fly a true course. It looks rather like a miniature airplane bomb.

The nose is fitted with a superquick, point-detonating fuse. This is held safe by a cotter pin attached to a wire ring, which is jerked loose just an instant before the shell is dropped into the mortar muzzle. But even then the projectile is not completely armed—not until a brass plug is blown out of the side of the fuse by the force of the propelling charge. This happens just as the shell emerges from the muzzle, and not until then is the TNT charge ready to explode. The thing is practically foolproof. If the

AMMUNITION BAGS, each with a capacity of 12 rounds, hang over the men's shoulders, one in front and one at the back. The highly accurate and foolproof shells are equipped with tail fins to carry them true to their mark

propelling charge misfires, the barrel is simply tipped forward, the shell caught by its sides as it slides out. The cotter pin is put back, and it is safe again.

The propelling charges are even more ingenious. The basic charge is a cartridge inserted in the rear end of the projectile, much as for a shotgun shell, but it is entirely filled with powder. The chamber into which this paper cartridge fits is perforated at the sides, so that the explosion bursts out sidewise between the fins into the space behind the belly of the shell. Each of the fin blades has a slit in it, parallel with the shell's axis; and into these slits are inserted, diagonally, little square bundles of sheet powder, looking much like bits of photographic negative. These bundles are held in place by their corners in the slits, and any one or all of them can be easily pulled out.

Thus the full charge is made up of separate parts. For close work all the increments are removed. For middle zones of fire, one or more are removed. With these variations, and changes in the elevation of the barrel, any desired range can be accurately obtained.

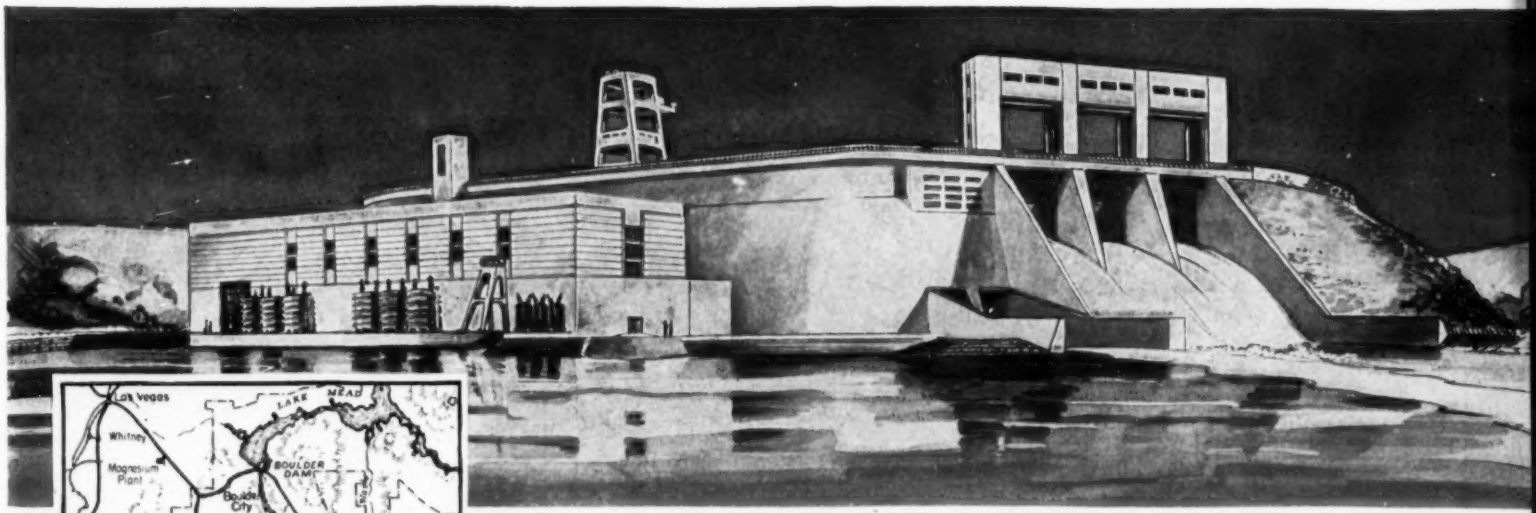
The mortar squad is a closely knit combat team of five men, including a corporal who combines the duties of squad leader and observer. Going into action, the corporal carries the mortar's base plate, spare parts, sight, field glasses, and compass. The gunner carries the mortar tube and bipod, while the assistant gunner and two ammunition carriers carry twelve rounds each. The ammunition bag hangs over the shoulders, front and back, with a hole at the center to let the head through. Additional ammunition supplies are parked in a quarter-ton truck close to the scene of firing.

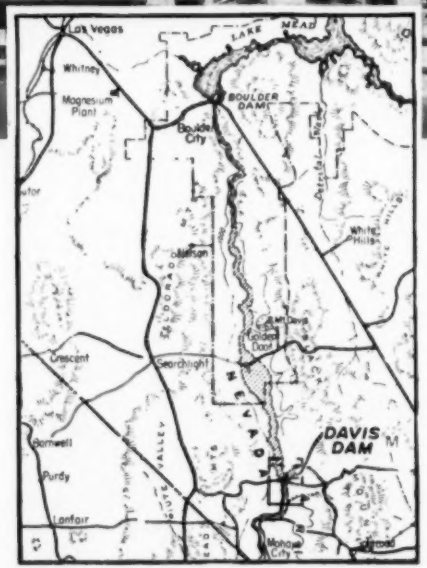
The mortar is set up for firing usually in a small gully or other protected place, where only another mortar can get at it. The corporal places an aiming stake nearby, for the gunner to sight on, and then takes a sight on the target with a lensatic compass, to obtain the approximate azimuth. For range he is dependent at the start on his ability to judge distance, and art in which he has been thoroughly trained.

While the gun crew remains protected, the corporal takes his position at a point where he can see the target, observe the shell bursts, and correct the firing. Though the first shot may be wide and short, the next two or three bring adjustment, as the gunner, lying on the ground at the left of the mortar, keeps his sight trained on the aiming stake and makes the changes shouted by the corporal. Then the order is to fire for effect, five shots in rapid succession. The assistant gunner does the firing, lying at the right of the mortar, dropping the shells in with his left hand.

Falling on its nose, each shell explodes on contact, and the burst affects a wide circle. Through natural dispersion, five shots cover a large area. The effect on enemy personnel is devastating.

You may hear more about the big guns, the monsters that roll into action on high-speed axles behind powerful prime movers. They are more sensational and make striking pictures. But when it comes down to close-range fighting with enemy machine guns and infantry, the little 60-millimeter mortar will be right in there, clearing the way for the advance. The Axis will hear from our vest-pocket cannon.





Nearly 70 miles below giant Boulder Dam, the new Davis Dam (in the drawing at the top of the page) is being built to supplement the power of Boulder and the recently completed Parker Dam downriver

Third Dam Rises on the Colorado

TO HELP satisfy a demand for electric power in the Pacific Southwest which has already surpassed a record output, the mighty Colorado River will submit to a third harnessing. This new engineering feat, called Davis Dam, is a 338-foot high, 1,350-foot long earth-and-rock-fill structure in western Arizona about halfway between Boulder Dam and the recently completed Parker Dam. Its construction is being undertaken in wartime because Boulder Dam's output, recently increased to 869,800 kilowatts, has proved insufficient and the 90,000 kilowatts being added by Parker Dam this fall has been absorbed in advance.

Work done under private contract, with the supervision of the Reclamation Bureau, will be finished in 1946 at a cost of $20,000,000. The project will completely block the river and impound 1,940,000 acre-feet of water stretching upriver 67 miles to the Boulder Dam tailrace.

The Colorado will be carried around the new dam by a diversion channel 200 feet deep and 4,500 feet long. The powerhouse will contain five generators and turbines with an output of 225,000 kilowatts to add to that of the two other plants.

MOVIE
CARTOONS SHOW

HOW AN ANTITANK GUN WORKS

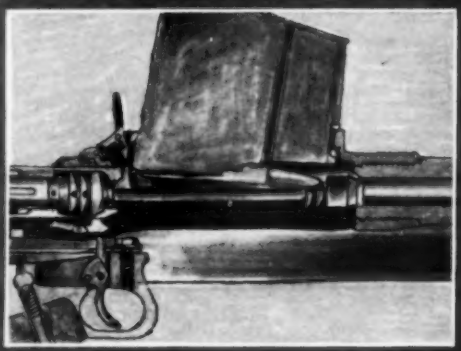
Walt Disney's Animated Art Quickly Teaches Soldiers Details of Caring for and Using Canada's MKI Rifle

• •

In the field, the MKI can be handled by one man in combatting tanks. Cartoon movies of it in action, with close-ups of its working parts, do much to speed the training of the men who use it

How a bead on an enemy tank looks to a soldier manning Canada's MKI .55 caliber antitank gun

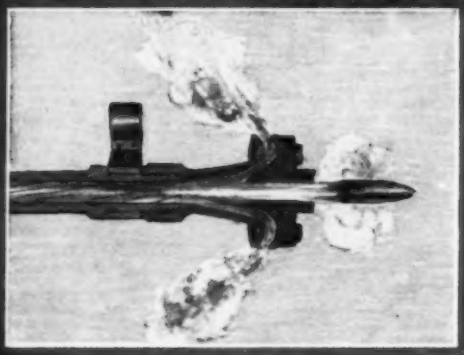
Cartridges—.55 caliber and armor piercing—are fed into the breech as fast as the gun will shoot



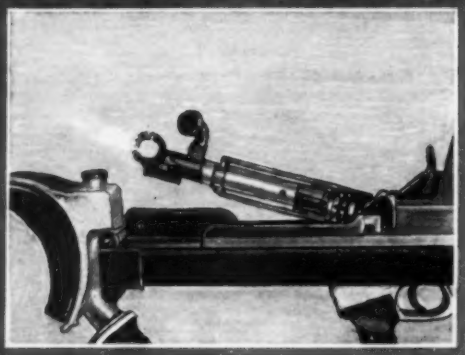
The sights can be adjusted for either 300 or 500 yards by manipulating the mechanism in the cartoon above

And here is the other end of the one-man antitank gun — a tank's-eye view straight down the muzzle

Some of the recoil is taken up by the odd-looking gas chamber shown below at the end of the barrel



Detail of the firing mechanism. These are frames from the Disney cartoon on operation of the gun



A TWO-REEL moving picture, produced by the Walt Disney studios as part of Mickey Mouse's war effort, is being used with great success in training soldiers to operate the famous Canadian antitank rifle, the Boys MKI. Combining both live action and cartoon animation, the film reveals every important detail of setting up, camouflaging, aiming, and firing the gun, with some sequences repeated for emphasis. Canadian military authorities say that a soldier can learn more from one showing of the picture, which runs about twenty minutes, than from a dozen lectures and demonstrations.

The MKI, a portable one-man gun which fires an armor-piercing .55 caliber bullet, is regarded by ordnance experts as one of the most effective weapons developed during the present war. It can knock out light tanks at 300 yards, and under some conditions can stop medium and heavy tanks. To impress the soldier with the power of his weapon, the Disney picture opens with a comedy sequence in which a cartooned rifle is shown blasting tanks coming head-on, diagonally, and at right angles across the field of fire. This sequence also demonstrates that to hit an oncoming tank the gunner must lead it as if he were shooting into a flock of swift-flying geese or ducks.

In the remainder of the picture, the antitank gun is broken down part by part, and cartoon animation shows in detail the operation of each part, from the recoil reducer in the muzzle to the feeding and ejection of cartridge cases. Most of these sequences are repeated, so that the gunner can see how the gun is loaded, sighted, placed on the target, and fired. Details of the cartridges are shown, and of the muzzle and firing mechanism. In all of these sequences enough comedy is injected to keep the soldier amused while being instructed. At the end of the cartoon portion of the picture, a Canadian sergeant repeats in live action every lesson taught by the animated cartoons. Even civilians who witnessed the film were confident that they could pick up an MKI and blast a German tank out of existence.

Inventions CAN WIN

HERE ARE SOME HINTS FOR THE FREE-LANCE INVENTOR IN WARTIME

Don't be discouraged because you are not an "expert." Your very inexperience may give you a fresh slant on something the specialists have overlooked. Study the field of work you know best; maybe you can suggest a method to speed war production or save some critical material. If you have an idea for a military invention, study military literature and military journals to find out what has already been done in the same line. Send a complete description to the National Inventors Council, Washington, D. C.

DON'T

SUPERMAN IDEAS. The more spectacular an idea is, the less chance it has to prove practical. A humdrum device may weigh more in the scales of war than a "death-ray" gun

ANTI-SUBMARINE NETS for ships. The U-boat war has put a lot of minds to work on this problem, and its possibilities have been explored by the experts

SHOTGUN ANTIAIRCRAFT FIRE is another overworked field. Trained ballistics men with access to the lessons of battle experience, know all the answers

FLOATING AIR MINES also are best left to the experts. In the same class are explosives dropped by parachute, freak types of projectiles, and bombs

MINIATURE SUBMARINES and mother ships for submersibles may be left to the naval designers. The same thing goes for floating air bases and freak vessels

DO

MOBILE LANDING-FIELD LIGHTS. Also, ice-prevention devices, better landing brakes, diveproof lubrication systems, light hydraulic power equipment

BOMB PROTECTION for cities, buildings, and ships. Light armor and armored clothing. Extraction and refining processes for utilization of low-grade ores

TANK ENGINES of simple design for easy servicing. Tank transmissions for improved maneuverability. Gasoline injection equipment to replace carburetion

HYDROCARBON VAPORS as explosives. New coolants for liquid-cooled aircraft engines. Lower fuel consumption for aircraft. Improvements in superchargers

ROCKET PLANES may seem to fall in the Superman class, but this method of propulsion holds possibilities for war use. Minesweeping devices also welcome

IN THE summer of 1940 Goering's airmen, flushed with their victories in Norway, Belgium, Holland, and France, swept over Britain. There they were met and thrown back by some 3,000 R.A.F. flyers. Several factors played a decisive part in that historic defeat. The heroism of the young men in the Hurricans and Spitfires was one of them. But heroism does not enable a flyer to see an attacking plane in the dark. There was also a technological factor—the British were equipped with a radio location device by which, in effect, they could see their enemies at night. Without it they would have been unable to bring them down in such vast numbers as to make Goering hesitate—and when he hesitated he was lost.

This is a sample of the part invention is playing in the war. Until recently the radio locator could not be mentioned in print, and even now it can be no more than mentioned. But it is a fact that without this particular unpublicized invention the British might well have gone down to defeat. Dr. Vannevar Bush, speaking recently on "Science and National Defense," said that "radio detection, developed by a group of devoted British scientists working from 1935 on, at times without much encouragement, offset the element of surprise. This one development may have saved the isle of Britain."

Dr. Bush should know, for besides being

THE WAR

HAVE YOU AN IDEA THAT MIGHT HELP?

president of the Carnegie Institution of Washington, he is, as director of the Office of Scientific Research and Development, our chief co-ordinator in the field of organized wartime invention. It takes some co-ordinating. Before the war, out of 170,000 manufacturing companies in the United States, only 1,800 maintained research laboratories, and of these only a few hundred were big ones. The number of industrial research workers did not exceed 33,000. As Herbert Hoover never tired of pointing out, we were not doing enough research. As a result, now that we are at war we do not have nearly enough trained scientists to work on the problems which the Army and Navy are pressing for immediate solution. Needless duplication must be avoided, and that is one responsibility of the Office of Scientific Research and Development and its subsidiary, the National Defense Research Committee, headed by Dr. J. B. Conant, whose side line is the presidency of Harvard University. Another is to make sure that the most urgent things are done first, and that the results of research in one field are articulated with those in the others.

The NDRC is responsible for the bulk of the non-medical scientific work required in connection with the war effort. Yet it has no laboratories and does no research of its own. It farms out research projects to existing laboratories—a model of 100-percent subcontracting. At last advices it had over 450 research projects operating under contract, involving the technical facilities of some of the most important university and industrial laboratories in the country.

Every one of these 450 projects is highly confidential. The men working on the various problems, although all of them have been investigated and approved by the Federal Bureau of Investigation, are not told of other problems allocated to other groups, unless these are so closely related as in effect to be one. Scientific candor, the free exchange of information, mutual helpfulness, are all washed up during a war. A few key officials at the top necessarily know everything that is going on. Down

"Dry-Ice Gun" Harnesses Carbon Dioxide to Propel Bullets

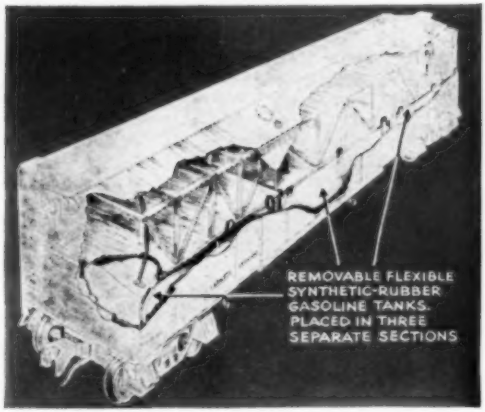
HARNESSING the tremendous expanding force of carbon dioxide to propel a projectile is the idea that Ray Monner, 33-year-old inventor of Denver, Colo., has applied in the "dry-ice gun" he recently offered to the U. S. Government. A single magazine of crushed dry ice, or solid carbon dioxide, is said to fire the gun 1,800 times, maintaining a constant pressure of about 1,170 pounds to the square inch. With modifications, the weapon can match the performance of any gun using powder ammunition, according to the inventor. Operating cost would be about 20 percent of that of a conventional gun, Monner says, because of the low cost of dry ice as compared with that of powder.

Ray Monner, at left, and his associate Earl E. Paul, examining a model of the "dry-ice gun" the inventor offered the Government

THESE IDEAS ARE

IDEA Gear wheels made of cotton are releasing large amounts of metals for other uses. Compressed cotton fibers, held together by steel shrouds and threaded studs, make a gear that is said to be 30 to 40 times as resilient as steel, permitting tooth deflections which absorb vibrations and reduce operating noises. In making the gears, cotton fibers are laid flat and straight to form a batting, which is given an oil treatment and compressed. Disks cut from the compressed batting are assembled between steel shrouds and held under pressure while holes are drilled and tapped for the studs. The blank is now ready for machining into the finished gear. It was developed by General Electric.

IDEA Collapsible fuel tanks of synthetic rubber offer a solution to the pressing problem of transportation of oil and gasoline. Developed by the Glenn L. Martin Company, they are an adaptation of the fuel cells developed several years ago by Martin for use in airplane wings—from which, in turn, evolved America's first self-sealing tanks for warplanes. "Mareng cells," as the new tanks are called, can be fitted into railway cars as illustrated below, and also into trucks, barges, and other transportation units. After carrying fuel to its destination, they can be folded compactly and returned by express.



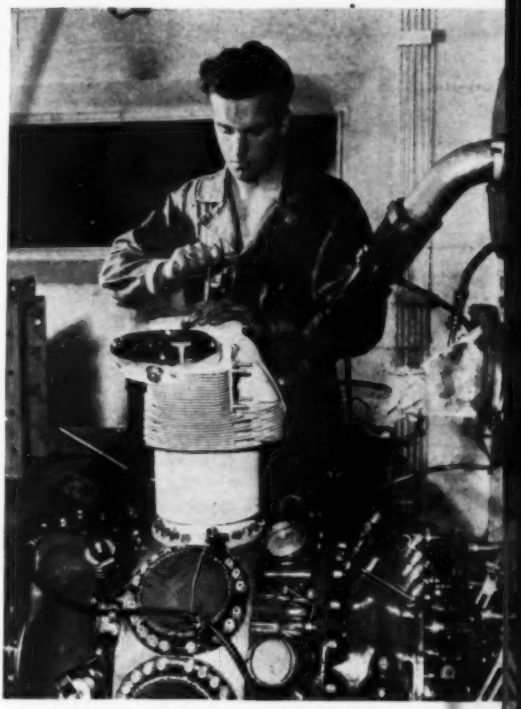
IDEA Lightweight body armor for modern soldiers, similar to the experimental British equipment shown below, is one of the needs being explored by our war research. Surveys made in the First World War showed that a large proportion of the deaths in action were the result of chest wounds, relatively few such casualties surviving to reach the clearing stations. The armor illustrated was designed by Dr. K. Walker, a well-known British surgeon and member of the Royal Society of Medicine.

the line each specialist is told only what he must know to do his part in the national effort. OSRD members listen; they do not talk. They know that the results of scientific research may be as important to national security as the movement of military forces.

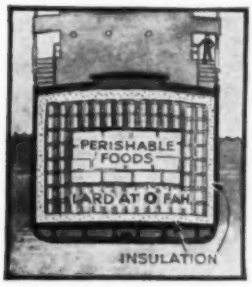
Some of the work which the scientists are doing resembles military operations in another way: it is quite as hazardous. During June of this year two Navy blimps, the G-1 and L-2, collided off the New Jersey coast. One man was saved; twelve were lost. Among the dead were four civilian scientists engaged in research for the Navy on what was described as "an experimental mission involving some hazard." The OSRD was not overstating the case when it said that these men had given their lives for their country as truly as any soldier or sailor killed in battle.

The men and organizations so far dealt with comprise the elite of the scientific world, the professionals, the insiders. The Government comes to them. They are fully employed, doing the things for which their abilities fit them, and conscious of their importance in a time of crisis. But what of the independent inventor, the outsider who has ideas which he hopes may be helpful? Certainly not all the useful ideas come from

IDEA Test stands for single cylinders are speeding production and improvement of aircraft engines by the Wright Aeronautical Corporation. Used in trying out new designs in valves, pistons, spark plugs, and other cylinder parts, each of these stands uses only one easily changed cylinder. As shown in the photograph at the right, plates cover all the other cylinder openings in the crankcase on the stand. A battery of these stands releases the full-size test cells for use with engines that are complete and ready for installation in planes.



IDEA Using frozen lard as a refrigerating medium in the holds of ships is the ingenious plan devised by Department of Agriculture officials to insure delivery of perishable foods to our allies and to American troops abroad in spite of possible loss of refrigerator vessels. The lard, in large containers, is chilled to zero F. or lower and used to line the hull of the ship, which has previously been insulated. Another layer of frozen lard is placed on top of the cargo, with more insulation above it. Tests of the plan have already been made successfully, using lard purchased by the Agricultural Marketing Administration for lend-lease purposes. The plan has the additional advantage of saving the space normally taken up by refrigeration equipment.



within the charmed circle. No circle is big enough for that in a country of 130,000,000 people.

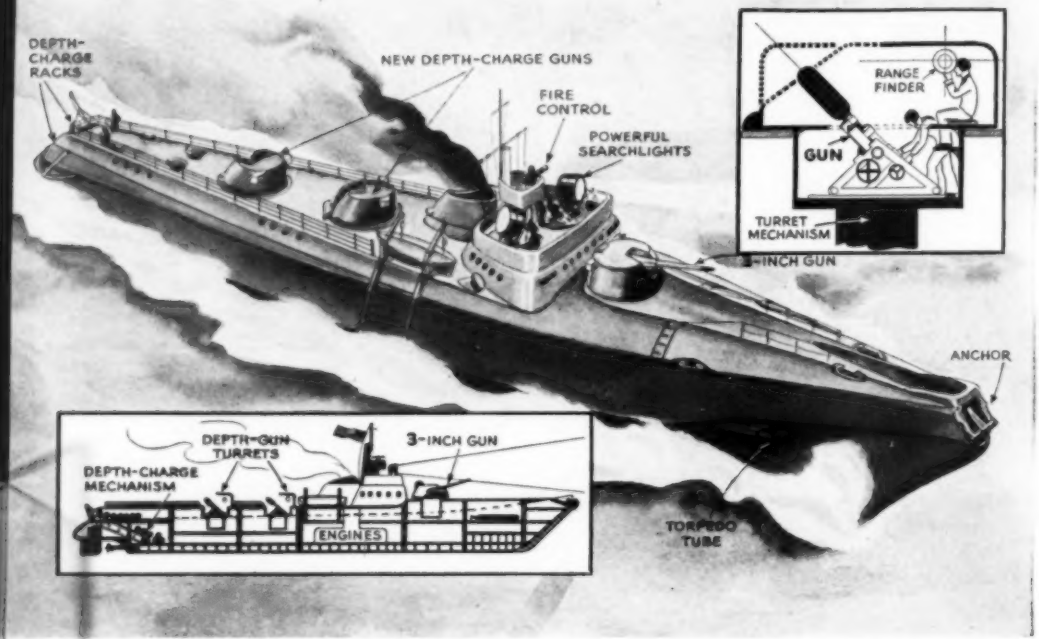
The government is well aware of this. Some months ago the War Production Board announced a system of awards, certificates, and citations for American workers who devise means for more and better war production. It was an excellent idea, long overdue. In ordinary times we waste much of our collective inventive ability, like everything else. But now we need all of it we can get, in every shop, mill, and factory, and from sources as yet unrelated to the war effort.

The American public is inventive by nature, and war stimulates the flow of ideas. For the free-lance inventor the Government has set up the National Inventors Council of the Department of Commerce, headed by Dr. C. F. Kettering, who for many years has been in charge of the research activities of General Motors. In 16 months of operation the Council received about 90,000 communications—an average of 1,300 a week. After Pearl Harbor there was a big jump, and in one day 2,400 pieces of mail came into the office. Of the 90,000 communications, 55,000 contained inventions or inventive ideas, a surprising percentage of which were found to have merit. Some have been accepted by the Army, Navy, and other Government agencies. For obvious reasons what they are, and how they work, cannot be disclosed until after the war. But the Council solicits ideas and faithfully performs its function of acting as a liaison agency between the outside inventor and the armed forces.

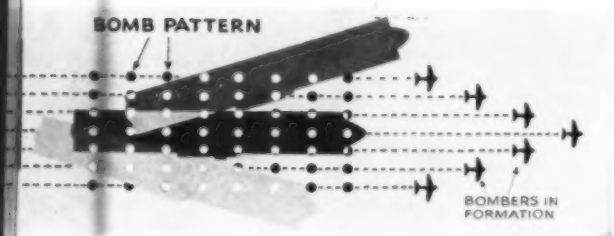
By no means all of the inventors who contribute to the NIC are amateurs. Corporations like Westinghouse, General Electric, Johns Manville, Douglas Aircraft, etc. forward ideas which are not in their lines of work, as the most effective way of bringing them to official attention. Some suggestions come from men in the Army and Navy who have not been successful in promoting their ideas through the regular channels of the services. In several cases privates have received commendation as a result of contacts with the National Inventors Council. One man who was driving a jeep was commissioned when he came to the attention of higher Army officers by this route. Before that his technical qualifications had been lost in the shuffle.

The Council acknowledges all communications, classifies them, and refers every idea received to one or more staff engineers

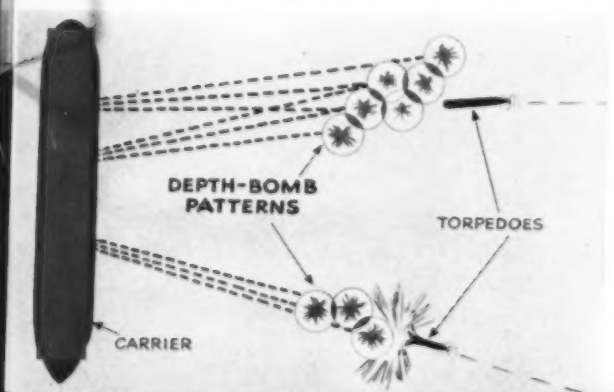
. . . . AND THESE SUGGESTIONS HOLD PROMISE



FAST SUB CHASERS like this, armed with long-range depth-charge guns, could make short work of U-boats. Unlike the familiar Y gun, these weapons would place charges accurately at great distances

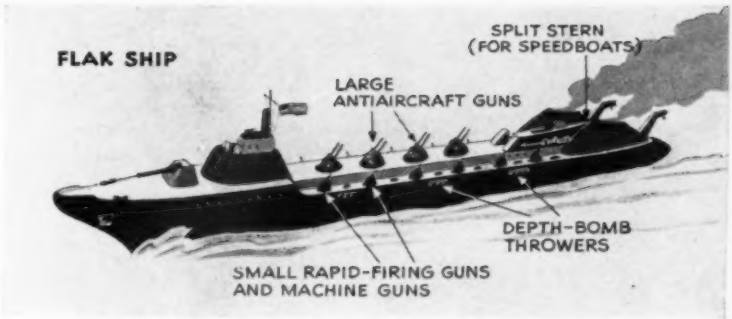


DEFENDING A CARRIER. Horizontal bombers attacking a carrier must lay a bomb pattern like that shown above, and the best protection is an umbrella of fire from "flak ships." Against the equally deadly torpedo plane, Martial & Scull propose a screen of depth-charge explosions which would explode torpedoes or turn them aside from their course

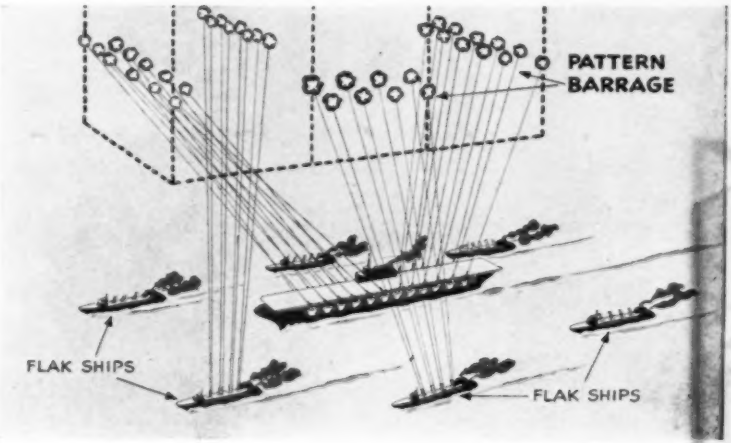


BECAUSE it carries the longest-range artillery—namely, the bomber—the aircraft carrier has become about the most important of naval vessels, but it is also the most vulnerable. To protect it against its deadliest enemies, bombers and torpedo planes, is the purpose of two inventions of Martial & Scull, industrial designers of New York City. One is a "flak ship," a floating anti-aircraft battery designed as an escort vessel for carriers. Heavily armed with rapid-firing long-range guns, several of these could establish a rectangle of explosions at various levels above a carrier to break up bomber formations. The other invention is a gun for firing depth charges at long range to form a screen that would explode or deflect torpedoes dropped by planes. Guns of this type could also be mounted on fast sub chasers like the one shown in the artist's drawing at the top of this page.

FLAK SHIP. Floating antiaircraft batteries, escort ships of the type pictured at right would give carriers necessary protection against both dive and horizontal bombers. Heavily armed with multiple rapid-fire cannon and .50 caliber machine guns, they are much better fitted for the task than are destroyers and cruisers



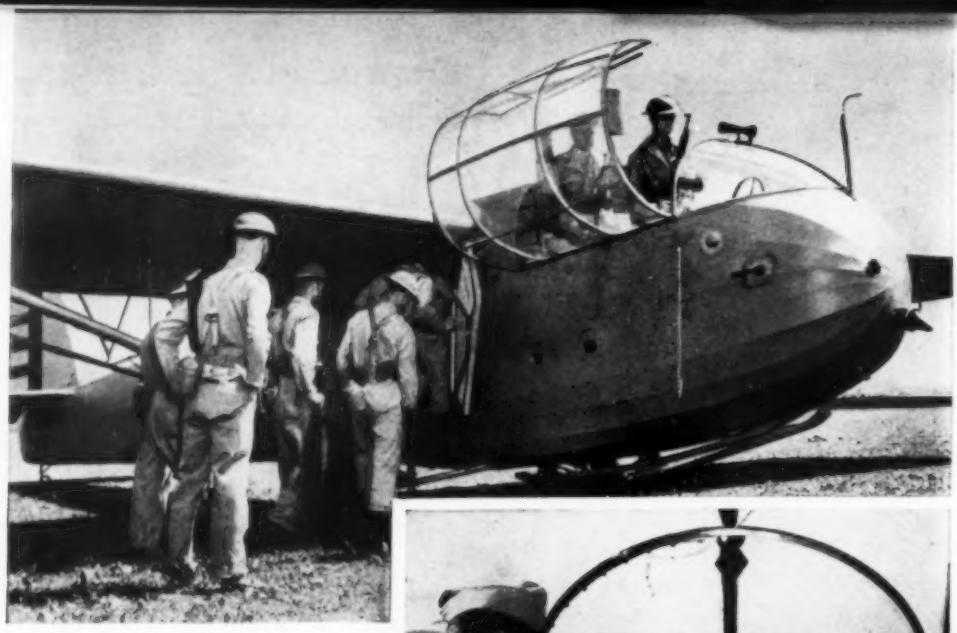
A BOX BARRAGE kept moving above the carrier by long-range guns, with shell bursts at various levels, would establish a pattern to break up a formation of horizontal bombers and prevent its laying a bomb pattern like that shown on the opposite page. Machine guns would give special attention to the enemy dive bombers. Carrier's own antiaircraft guns would help out those of the flak ships, as seen in the drawing at right



qualified to appraise it. Those which seem promising are passed on to one of a dozen technical committees—on ordnance and firearms, vehicles, aeronautics, signals and communications, chemicals and chemical warfare, etc. The inventions which pass the committees are then considered by the Council as a whole, and, when approved, are forwarded to the Army or Navy, or both. At this point the Council's responsibility ends, and any subsequent arrangements for the use of the invention are made between the inventor and the appropriate department.

The chief handicap of the Council is that, like the Office of Scientific Research and Development, it can listen but not talk. The military service will not permit it to instruct inventors as to what devices are particularly needed. Such information would be of interest not only to the American public, but to the enemy. Thus, as Dr. Irwin Stewart of the OSRD remarked to the writer, the independent inventor starts with two strikes against him. But this should not deter him from trying. There is always the possibility that the outsider will dredge up a valuable idea. Every man's life history is unique, and the random experience of some amateur may give him a slant on a problem which a professional investigator, however astute and well-informed, will overlook. The odds against the outsider are long, but the fact remains that some of the most notable military inventions, like smokeless powder, rifled cannon, the machine gun, and the airplane, were made by civilians.

Although the inventor who is eager to serve his country cannot be brought into the military background and must perforce work pretty much in the dark, some do's and don'ts may be offered for his guidance. In general it is well to avoid ideas and devices of the Superman type; the more spectacular they are, the less chance they have of turning out to be practicable. Again, some schemes have been worn to a frazzle—thousands of inventors have taken a whack at them, and the services probably know all there is to know of the possibilities. These include anti-submarine nets for the protection of ships, the *(Continued on page 220)*



Sky troopers file aboard a new nine-place Waco transport glider used for training by the U. S. Army Air Forces. Craft like this will be the spearhead of our aerial offensive. Specially trained glider pilots will man dual controls like those shown at right

SHIPS FOR

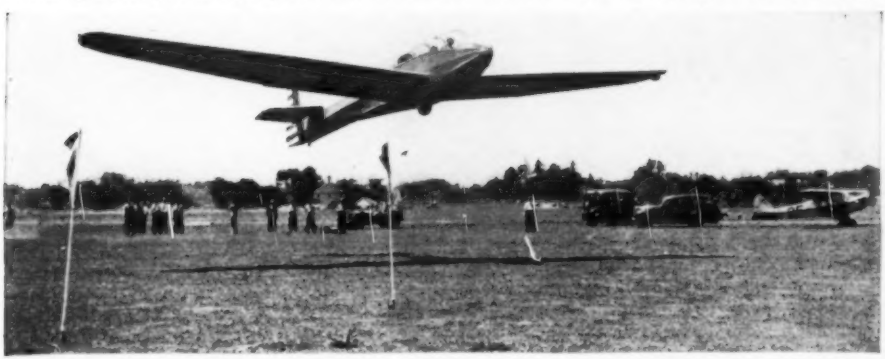
Our Air Commandos

A TRANSPORT glider capable of carrying nine fully equipped soldiers, the largest yet built in this country, has been developed by the Army Air Forces to aid in the intensive training of America's Commandos of the Air, troops who will attack the enemy from behind his own lines. The new machine embodies many novel features of construction, one of the most important of which is a new kind of landing gear. The ordinary glider comes to earth on wheels, but the new machine will land on skids, the wheel gear being dropped as soon as the glider has left the ground. Information and photographs describing this machine were recently released by the War Department.

Recovery of a glider after it has landed, however, remains one of the serious problems in transporting soldiers by air. In theory, a glider must be considered lost as soon as it touches ground in enemy territory, and full-scale operations would result in enormous losses. In an attempt to solve this problem, the Army Air Forces are experimenting with an adaptation of the pick-up and delivery system used by mail planes, in which a mail bag is suspended between two poles and picked up by a hook lowered from a plane. In tests at Wright Field, Ohio, a rope attached to a glider is run along the ground for several hundred feet to a point between two poles, where it is suspended for picking up by the tow plane's hook. So far

Taking a tip from the air-mail flyers, the Army is experimenting on picking up gliders off the ground with a plane in flight. Here a Stinson 10-C swoops over the pickup gear at more than 100 miles an hour

Snagging the pickup rope with its trailing hook, the plane yanks the glider into the air as seen below. Only light training gliders have been used in these tests so far, but the stunt suggests the possibility of using a pickup to retrieve gliders that have landed and discharged their troops in enemy territory



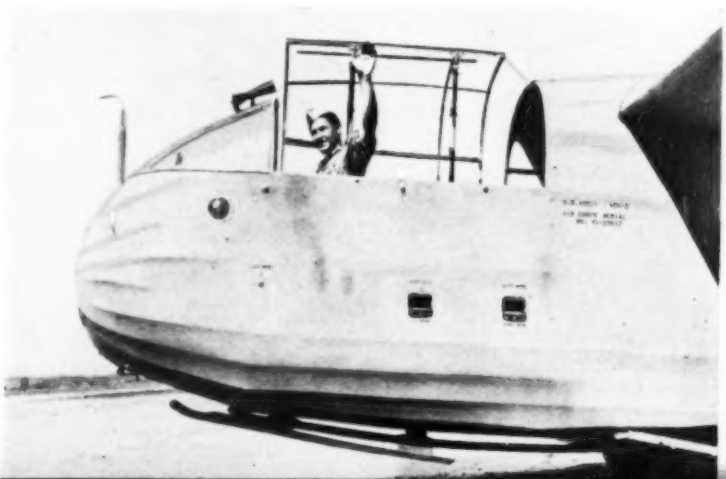
Britain, too, is turning to gliders as a means of transporting troops to battle areas. Above, an R.A.F. training craft slides in for a landing across a sister ship on the ground. Easy to manufacture in large quantities, motorless planes offer a practical method of moving considerable numbers of men by air

these tests, made with light training gliders, have been very successful.

Another development in gliders has been announced by the Aeronca Aircraft Corporation, which is transforming ordinary training planes into gliders by installing a special nosepiece in place of the motor.

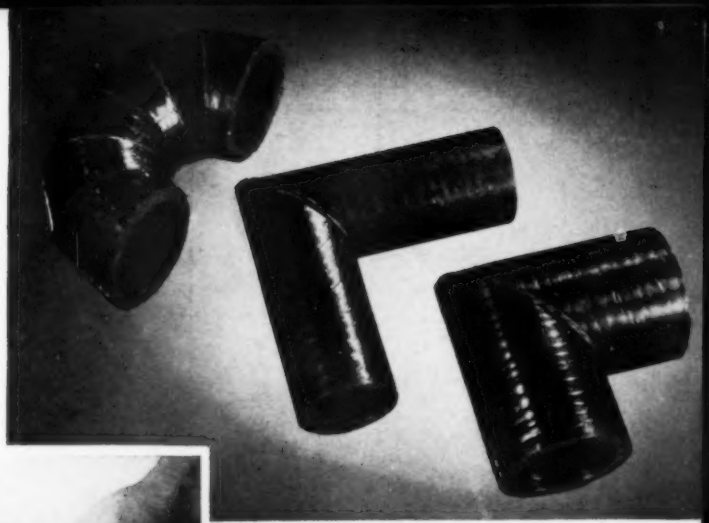
The key men of any offensive undertaken by the commandos of the air will be the glider pilots, and to handle these important machines the Army Air Forces needs thousands of men between the ages of 18 and 36, inclusive. A candidate must be a graduate of civil pilot training school, or hold a Civil Aeronautics Administration private airman certificate which had not lapsed prior to January 1, 1941, or be a former aviation cadet with at least 50 hours in training planes, or a veteran of at least 200 glider flights.

All armies recognize the possible advantage to be gained through transporting airborne troops by glider, and the construction of these simple machines has become part of all military building programs. One power airplane can tow several gliders, and after being cut loose thousands of feet up and miles away from their objective, the aerial commandos can glide silently in to strike their blows without warning. Also, the construction of a glider requires almost no strategic materials, and takes about one-fifth the money and a fraction of the time necessary to build an airplane.

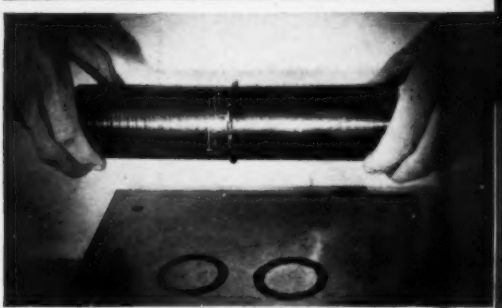


This is the nose of our nine-place Waco. Note the skids for landing. This glider takes off on wheels, which are dropped as soon as it is in the air. A transparent hood covers the cockpit for wide vision

PLASTIC WATER PIPE



To "weld" sections of plastic pipe, ends are held on a hot plate at about 350 degrees F. for five seconds . . .

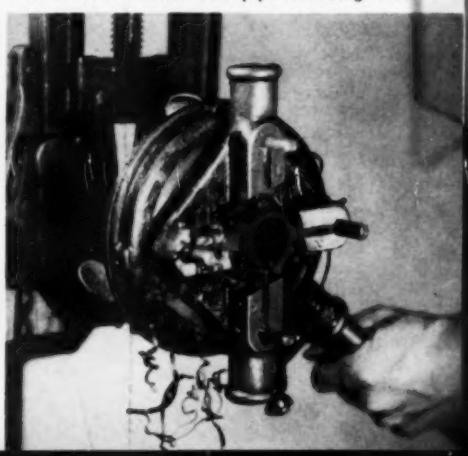


. . . and then pressed together for two minutes. Joints shown above are as strong as rest of pipe

PIPE made of a new, noninflammable plastic now releases iron, copper, and other metals of strategic importance in wartime. Available in a range of sizes from half an inch to two inches, the plastic conduits are well suited for household water piping. In addition, their resistance to corrosion by water, acids, alkalies, and organic solvents makes the pipes of prime importance to industrial plants. Threaded ends may be formed with standard iron pipe tools. For assembling a length of pipe, however, sections are joined by "welding" them together. Ends of the pieces are held for five seconds on a hot plate at about 350 degrees F., and then pressed together for two minutes while they cool. Another method employs a welding box, in which the ends of pipe are held by one man, while another applies a torch.

Another method, for joining long pieces, uses a welding box in which the ends are held while a torch is applied

Threaded joints can be made, if desired, by the use of conventional iron pipe-threading tools



"Welded" Wood Saves Metal in Fast Motor Torpedo Boats

FAST 30-ton motor torpedo boats, 70-ton rescue boats, and massive target boats made at a Canadian factory are being "welded" from wood by resin glue. Metal serves only for armament, engines, and fittings. Frames for the hull and wheelhouse consist of built-up wooden laminations of carefully chosen types of wood, bonded with the special glue. The same resin, chosen for strength, water resistance, and ease of application, serves in assembling engine beds.

Armed with torpedoes, the M.T.B.'s will join the Canadian and Netherlands navies for coastal patrol. The larger rescue ships, designed for such uses as dashing to a spot where a fighting plane has crashed in the sea, allow more room for stretchers and hospital equipment. Target boats, zigzagging across the water, train airplane crews using practice bombs.

Sprayed Aluminum Protects Airplane Motors from Rust

PURE aluminum metal, sprayed in molten form upon cylinders of radial airplane motors, now protects them from corrosion due to landings and take-offs in salt water. Tests indicate advantages of this method over enamel protective coatings formerly used, and aluminum-sprayed cylinders are reported used in increasing numbers on military aircraft. At right, the process is shown in use at one of the shops of the Wright Aeronautical Corporation. Fed into a spray gun, a fine piece of aluminum wire passes through an acetylene flame. Compressed air atomizes the liquefied metal and deposits it on the motor.

Melted by an acetylene flame in the spray gun, aluminum is atomized by compressed air and blown onto the cylinder to be coated

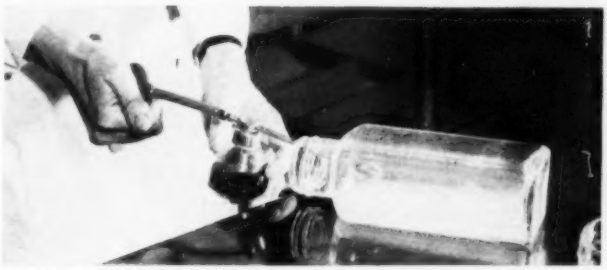
Mildewproofing for Cotton

BY MAKING cloth mildewproof, thousands of dollars worth of awnings, sandbags, sails, and other cotton items are saved each year. Chemists of the Department of Agriculture research center at Beltsville, Me., have discovered several different methods for mildewproofing cotton cloth—each method adapted to the particular use it must serve. All canvas and other cotton material used by the Army and Navy is now treated to resist mildew organisms as an aid to providing maximum wear and service in the field and at sea.

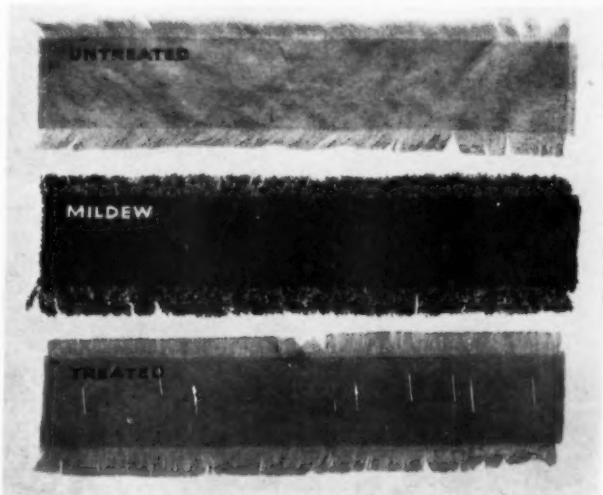
Housewives bothered by mildew on shower curtains, or other canvas articles, can do their own mildewproofing at home by soaking the material in very soapy water and then, without rinsing, dipping it into a solution of copper sulphate. This simple treatment will protect the fabric even after several home launderings, following which, of course, the material may be treated again with the copper-sulphate solution.

To test the susceptibility of treated cotton to mildew, a strip of the fabric is laid lengthwise in a bottle of nutrient agar, and sprayed with a liquid culture of the mildew organism. If it attacks the cloth, only carbon will remain. A sample effectively treated against mildew, however, will not carbonize or deteriorate. This scientific test requires an elaborate technique to be sure that the mildew organism comes in contact with the material under favorable conditions.

To test fabrics for resistance, the scientist puts a culture of mildew organism in distilled water, and warms the flask over a Bunsen burner



Then the solution is transferred to a sterile atomizer and sprayed on material laid in a sterile agar bottle. Below, from top to bottom, a strip of untreated cotton before and after exposure to mildew culture and a mildewproofed strip showing no deterioration after being exposed



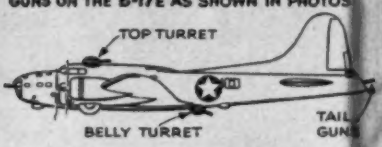
NEW GUNS AND TURRETS

STINGS FOR THE MOSQUITO FLEET

Specially designed turrets like this protect gunners manning .50 caliber machine guns aboard the Navy's fast PT boats. The new turret is intended to combine full aiming freedom for the gun with maximum protection for personnel

And this is a 20-millimeter automatic antiaircraft cannon mounted on one of the mosquito boats for use against low-flying planes and dive bombers. Guns of this type are being mass-produced by new methods which include the use of a vertical reamer operated by one man, which reams eight barrels at once. Below, a workman is smoothing the inside of a barrel

GUNS ON THE B-17E AS SHOWN IN PHOTOS



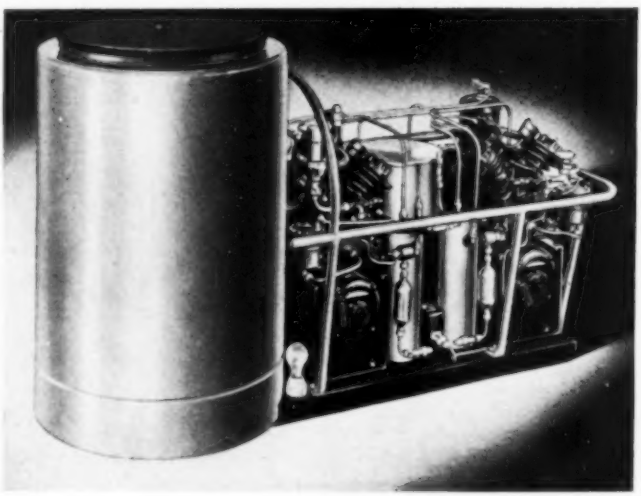
ON A FLYING FORTRESS

Guarding the big B-17E bomber against attack from above, below, and astern is the job of the gunners shown on this page. In the power-operated top turret, two guns are ready to pour a deadly stream of lead into a hostile fighter diving down on the plane. "Rat poison" is the appropriate nickname of the tail gun, above, which is responsible for keeping troublesome enemy craft off the Fortress' rear. At right, an Air Force sergeant shows the approved method of getting into the "belly bubble," a power-operated turret slung under the fuselage. This is about the most uncomfortable post on the bomber, as the gunner has to curl up in the bubble and may turn somersaults while firing his .50 caliber machine gun

Self-Propelled Crane Can Cart Planes off Bombed Fields

PLANES shouldn't be caught on the ground by an enemy raid on an airfield—but sometimes they are. Hence the U. S. Army Air Forces have developed a self-propelled crane of giant size, capable of picking up a 30-ton load and trundling it away at 18 miles an hour. Shown lifting a four-motored B-24 bomber, the mobile derrick is designed to clear air bases of planes damaged by hostile attack, so that those remaining in serviceable condition may take off and land without obstruction. The massive hoist rides upon enormous tires, paired at the rear. This demonstration, photographed at Wright Field, Ohio, marked the culmination of a long period of development, early stages of which were reported in this magazine (P.S.M., Jan. '42, p. 54).

Freezer Shrinks Metal Parts for Engine Fittings



SHRINKING metal parts is made easy by a super-refrigerator, capable of maintaining a temperature of 120 degrees below zero. After being kept in its cylindrical chilling compartment, bearings and other inserted fittings may be slipped into place by hand, without application of force that might tend to strain and deform them. For example, a two-inch ring of phosphor bronze contracts more than 3/1,000 of an inch in the cold chamber, an amount assuring ample clearance in precision work. The relative effect corresponds to a "shrink fit" made by heating the larger part and allowing it to contract, as it cools, upon the smaller one. Among other applications, the electric-powered refrigerator preserves the malleability of annealed aluminum rivets placed in it for storage; treats hardened gauges; and tests aircraft instruments.

WHAT YOU CAN DO FOR VICTORY

Evansville Mobilizes Skilled Home Craftsmen

SUCCESSFUL WPB EXPERIMENTAL ORGANIZATION IN INDIANA CITY SHOWS HOW SMALL-SHOP SUBCONTRACTORS CAN BE USED TO HELP NATION'S WAR EFFORT

By ARTHUR GRAHAME

CO-OPERATING with manufacturing companies which are anxious to speed up their war production by subcontracting some of their work, the Evansville, Ind., field office of the War Production Board has completed a successful experimental organization of home craftsmen.

Newspaper and radio publicity was used to call attention to the possibilities of bits-and-pieces subcontracting in southern Indiana and adjacent Kentucky, and Ralph C. Hubert, manager of the Evansville WPB office, undertook the registration. From the large number of replies received, William E. Brown, chief engineer of the Evansville office, selected 37 owners of home workshops who listed as their machine-tool equipment a total of 38 lathes, 37 drill presses, one shaper, one surface grinder, three power hack saws, and eight sets of welding apparatus. To test the skill of these selectees, he sent each of them a blueprint of three sample parts to be made to close tolerances. All submitted samples, and every sample submitted was satisfactory!

The samples proved that these home craftsmen — several of them POPULAR SCIENCE war-work registrants—were capable of high-precision work, but few of them were conversant with efficient production methods. What was needed was a manufacturer who could obtain medium-sized subcontracts which he would be willing to subcontract to home workshops. The right man for this supervisory function was found in a well-to-do business man who had started life as a toolmaker. He leased a shop, equipped it with secondhand machine tools, and obtained a small subcontract, with several larger ones in prospect. Most of the work is subcontracted to about 20 home workshops.

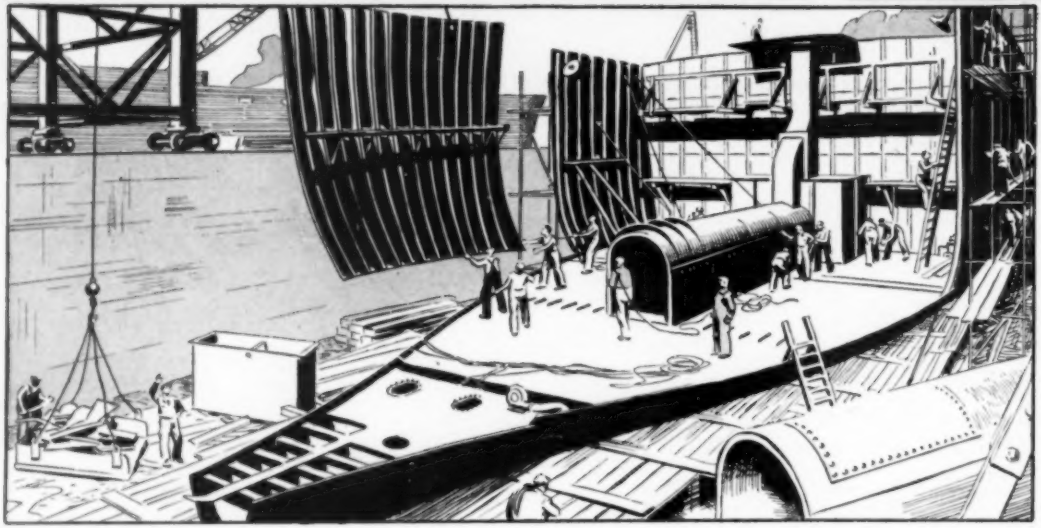
The Evansville WPB office has also co-operated with several independent small-shop owners who wanted to get into war work. One venture is run by a business man who supplied capital and shop space from patriotic motives, and a teacher of advanced machine-shop work in a high school, who manages the shop in his spare time.

The Evansville experiment should provide a valuable guide to the Government-sponsored Smaller War Plants Corporation, to which WPB's Contract Distribution Branch has been transferred.

• • •

To register in our war-work survey, send a stamped, self-addressed envelope to Popular Science War-Work Registration, 353 Fourth Avenue, New York.

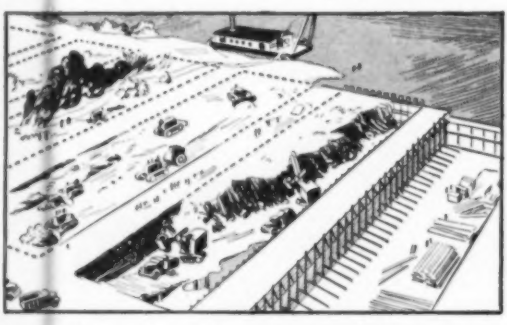
This is one of two girls who are machinists in a small Evansville shop which makes minor aircraft parts. Both girls were formerly waitresses



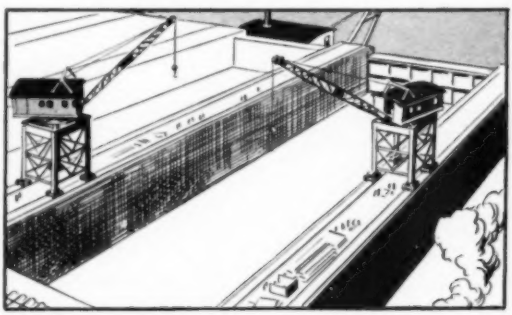
Huge prefabricated bulkhead of a war freighter lowered into place for assembly in a watertight basin

Building Ships Below the Sea

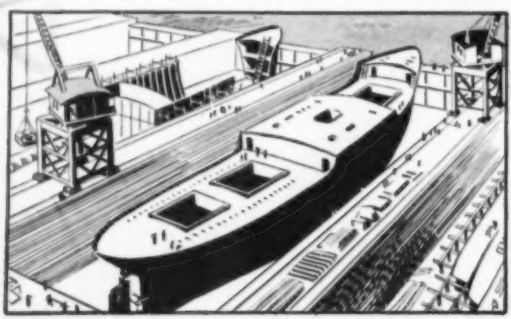
AN ENTIRELY new method of prefabricated-ship construction has been devised by American companies engaged in building a "bridge of ships" to carry supplies to the fighting fronts. Instead of constructing a vessel on elevated ways and then sliding it into the sea, the shipbuilder now does the work in a hole and lets the water in. In the hole, or basin, is a dry dock, similar to others in use heretofore, in which the building is done. When construction has been completed, a gated dam is opened, water flows into the basin, and the ship is floated into deep water for final fitting. Then the basin and dock are pumped dry and another ship is begun.



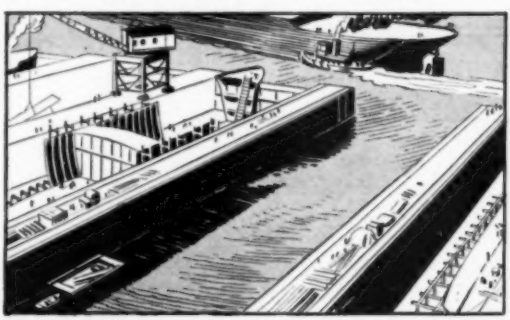
Here a dry dock goes up in one berth as a second basin is dug and work is begun on others near by



Next, cranes are moved into place for handling the prefabricated sections of a mass-production ship



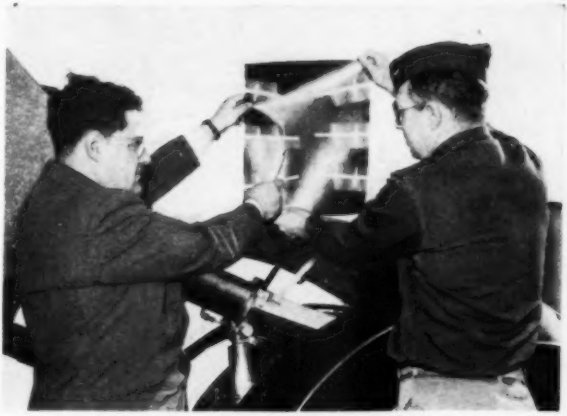
One ship is completed here except for fittings, and another is going up in the dry dock alongside



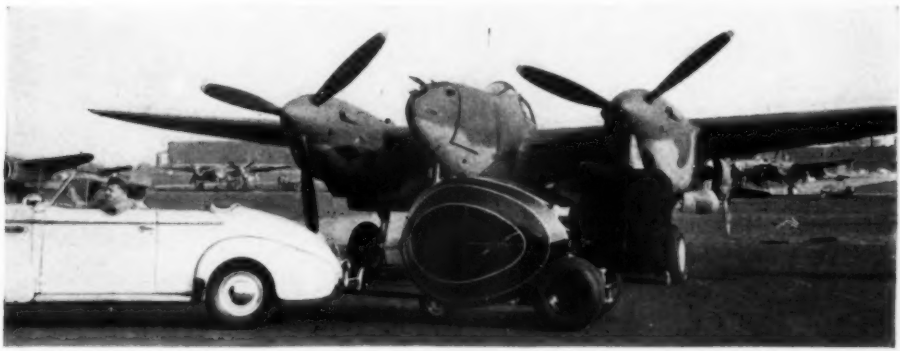
Watertight gate opened, the ship floats out. The dock will be pumped dry, and another ship begun

Trailer X-Ray Spots Plane Damage

THE question of whether an airplane has developed structural weaknesses or sustained some invisible damage that makes it unsafe can now be answered on the flying field by means of a new mobile X-ray laboratory developed for the Lockheed Aircraft Corporation but available to the Army and Navy flying force everywhere. This apparatus, complete with a darkroom, is carried on a trailer. On reaching the plane to be examined, the X-ray machine is lifted out on a boom, and the technician sets it up and takes pictures up to 14 by 17 inches in size. They are developed and examined on the spot for immediate action.



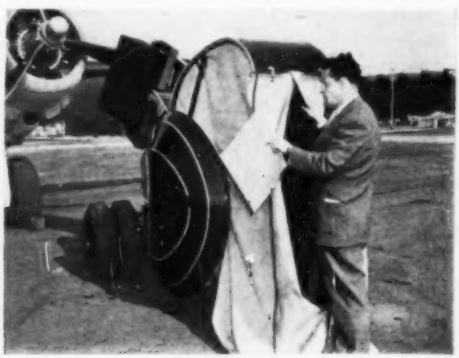
X-ray pictures developed at the flying field show damage and breaks to fighting planes in service and permit quick repair



This trailer, towed to the grounded plane by car or truck, contains X-ray and developing apparatus

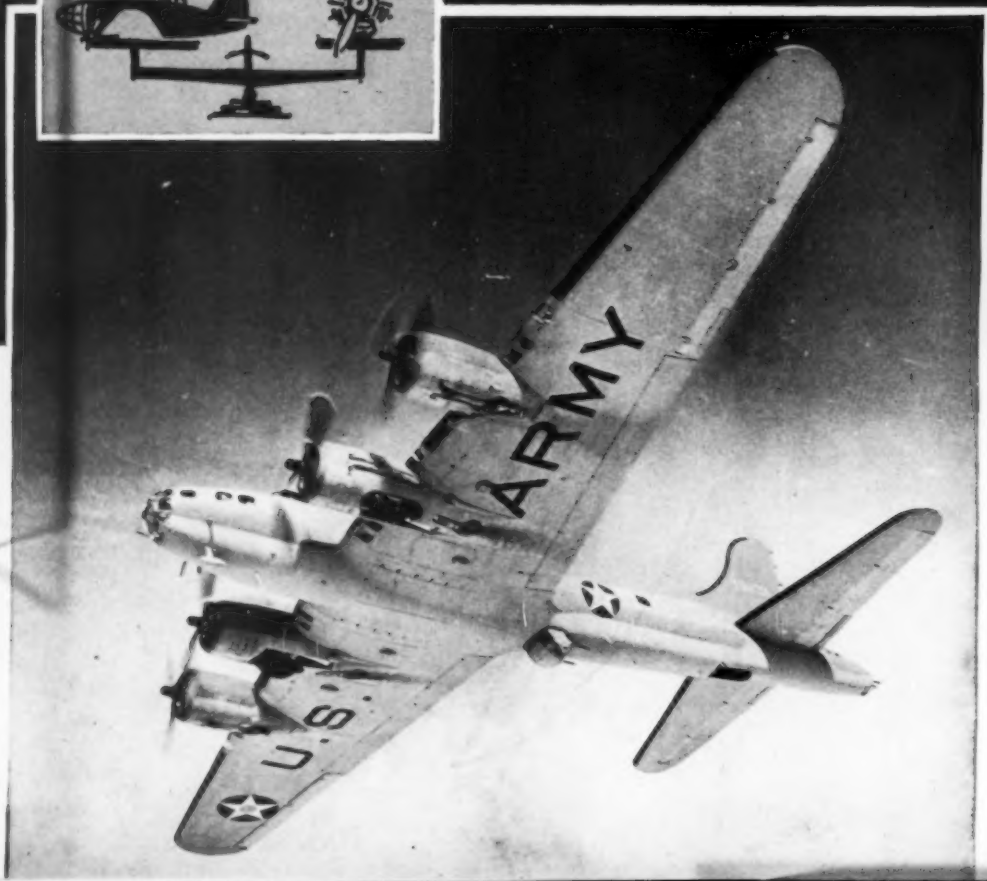
The mobile machine is brought out on a boom and set up for a quick photograph of a landing strut

And here is the darkroom—part of the trailer. The operator enters with an exposed X-ray plate



Our Warplanes Grow Stronger

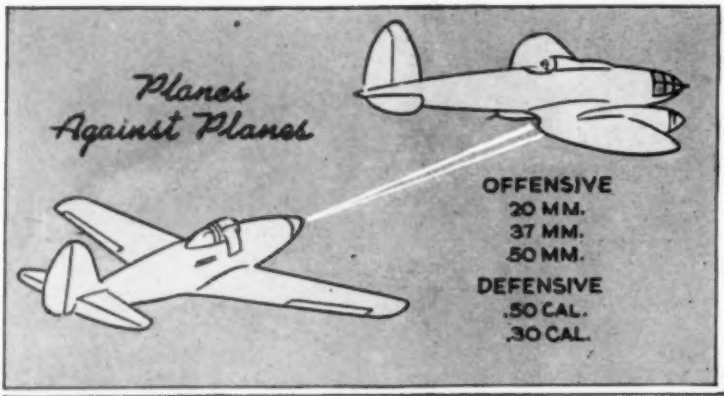
THE DESIGN ENGINEER NEVER FINISHES HIS JOB OF COMBINING MASS PRODUCTION WITH GETTING BETTER PERFORMANCE IN EVERY TYPE OF PLANE



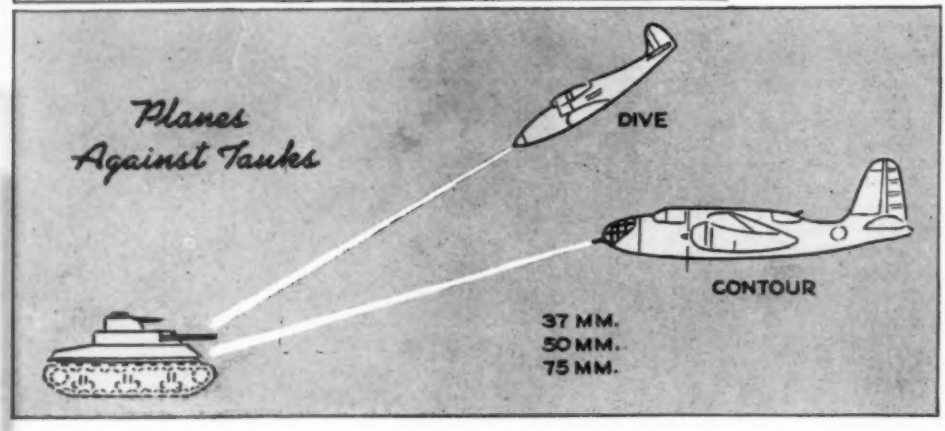
By CARL DREHER

SUPPOSE someone told you of a military airplane which was a marvel because it was streamlined *inside?* Offhand it doesn't seem to make sense. The purpose of streamlining is to reduce drag when air streams over a moving surface, and one naturally associates it with the wings, fuselage, and other visible parts of an aircraft. But that is not the whole story. Engines have to be cooled. About a third of the energy of a modern airplane motor is transformed into heat and that heat has to be led away or it will burn up the engine. It is led away by air which enters the airplane at one point and leaves it at another. As engines get bigger, streamlining the cooling system becomes almost as important as streamlining the airframe.

One of the best and fastest of the new high-altitude fighters, the 2,000-h.p., single-engine Republic P-47 Thunderbolt, owes its efficiency largely to internal streamlining. This plane, according to its designer, was practically built around the cooling system. A large air intake hole in the engine cowl was connected by ducts to the various heat interchangers and the supercharger. Another system of ducts conveyed compressed air from the supercharger to the engine. All the ducts were carefully dimensioned and directioned for maximum efficiency of air flow. This done, the airframe was designed



For destroying enemy aircraft, the trend is toward heavier guns—cannons of 20-mm., 37-mm. and up; machine guns up to .50 caliber for defense

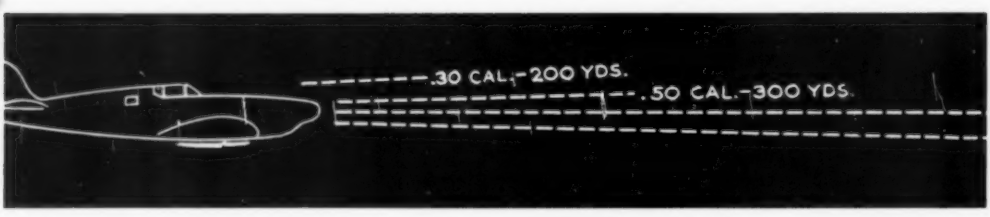


Against tanks, guns are more effective than bombs. For the best results, they are turret-mounted, not aimed by diving the plane at tank

around the duct system. The result was a fighter which flies a censorable number of miles over 400 an hour.

That is an example of modern design in the airplane field. Your plane designer is the last man in the world who can afford to stand pat. Airplanes are becoming faster, heavier, and more complicated all the time. The big ones are getting bigger and cruising farther. Big or little, they are flying higher and higher. All of which is both a headache and an inspiration for the design engineer. An inspiration, because he knows that on him rests the chief responsibility for keeping our planes a neck or a nose ahead of the enemy's. And also a headache, because on the one hand there is the cry for mass production and "stability," which if taken too literally may result in mass production of yesterday's planes, and on the other there is the Army's and Navy's need for tomorrow's planes and lots of them. The design engineer is in the middle, trying to satisfy everybody.

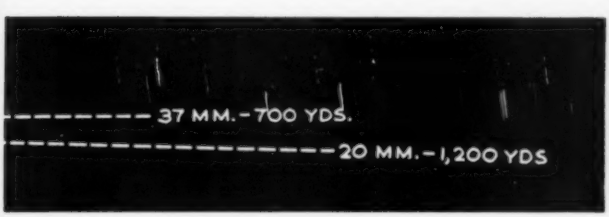
We must discriminate between standardization in the sense of interchangeability

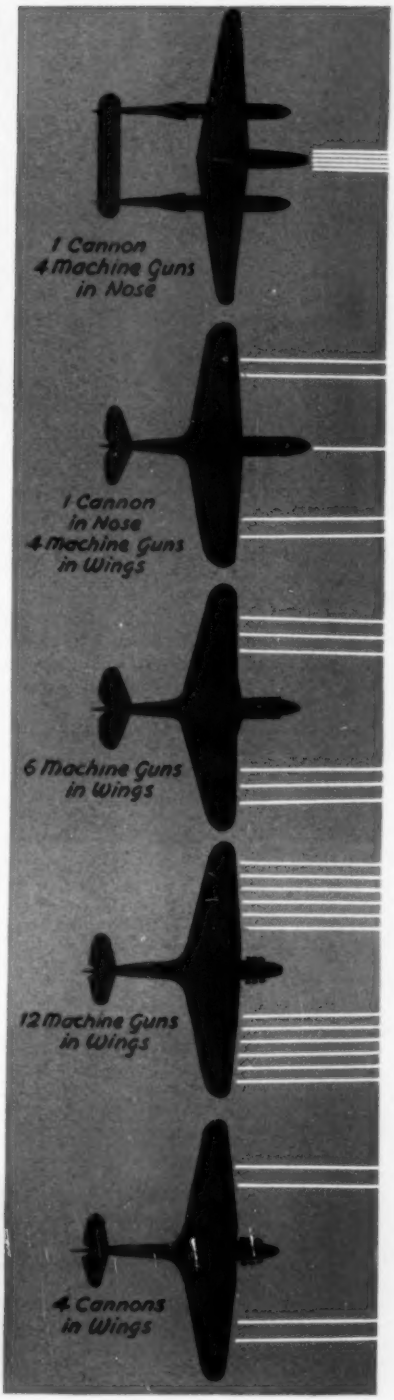


Plane-mounted 75-mm. gun of First World War had a two-way barrel to take up recoil. At right, basic gun arrangement is illustrated with five types of present-day fighters

and standardization in the sense of freezing design. The first is possible and beneficial, the second is impossible in the nature of modern war. As an example of the first, we have several companies building B-17's, Flying Fortresses. The parts turned out by one plant are completely interchangeable with the parts turned out by any other plant. But the B-17E is not the same as the B-17A. The first Flying Fortress was flight-tested in 1936. Since then the design has been in a state of flux, not continuous, but intermittent. At intervals certain parts were improved and fitted into the layout, and the same thing is being done today. There are certain old adaptables which have thrived under this procedure for years and have kept right up in front. Among pursuit planes the Spitfire and Hurricane, and our own Curtiss P-40 Hawk series, are in the same age group as the Flying Fortress among bombers. Such planes are old and always new, and they remain essential to the war effort. Equally essential are fresh designs like the Republic P-47 already mentioned; our two-engine fighter, the P-38 Lockheed Lightning; some Navy fighters like the Grumman F4F Wildcat and the Vought-Sikorsky F4U Corsair; and, among bombers, the fast medium-weight Martin B-26's.

Both in keeping old types up to date and in launching new ones the plane designer must never





lose contact with the fighting front. Fighting airplanes are designed for a purpose—killing and destruction. The purpose never changes but the methods of accomplishing it change all the time. The design room, the laboratory, the factory and the fighting lines are in constant interaction. Performance determines tactics and strategy, and *vice versa*. If you have planes which can fly higher or faster or maneuver better than the enemy's, you can plan your military operations accordingly. Conversely, if your planes prove inferior in some critical respect, the designers and manufacturers must know about it so that the deficiency can be remedied as soon as possible. This liaison function is chiefly the responsibility of the Air Force Matériel Division in the Army and the Bureau of Aeronautics in the Navy.

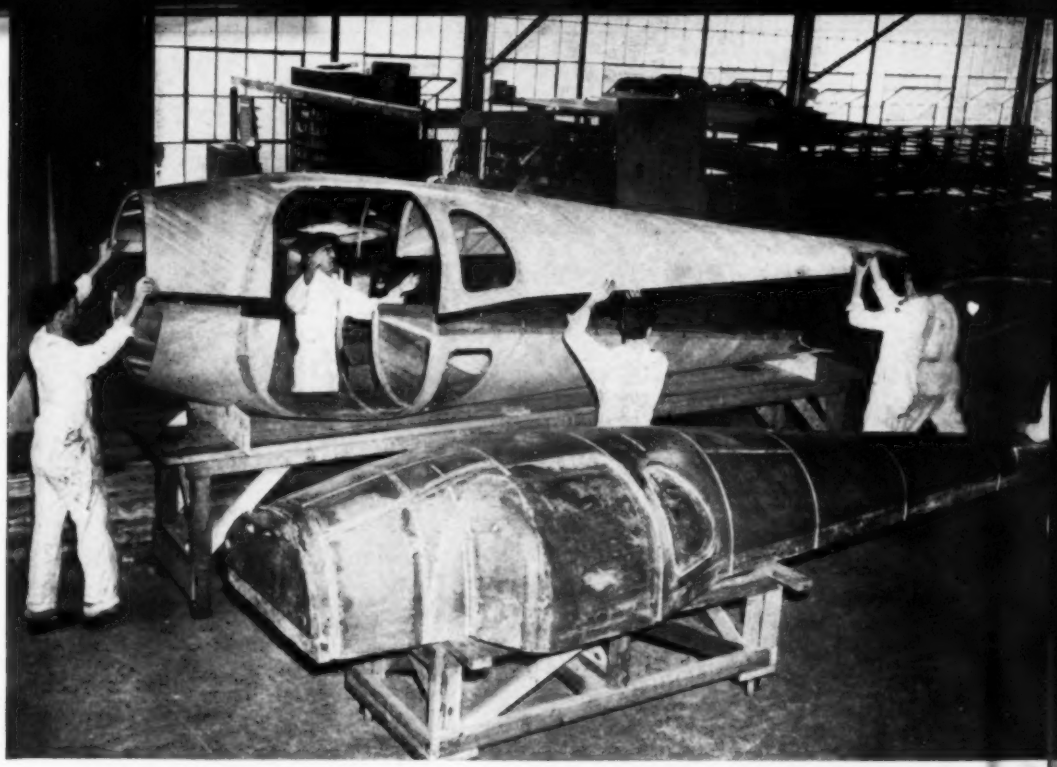
The importance of rapid and accurate interchange of information between the fighting front and the manufacturing rear can hardly be overstressed. The first American airplanes which were sent abroad, long before we entered the war, were undergunned and underarmored, and lacked such vital accessories as self-sealing fuel tanks. The British had to keep them on the ground until they could be fixed up. In the meantime the information on what was needed came back to the factories and adjustments were made in subsequent production. More recently the Japanese Zero broke into the news in somewhat the same way. The Zero is a light fighter in which speed, armor protection, and structural strength have been sacrificed for extreme maneuverability. Should we do the same with some of our fighters? The manufacturers are ready to make the change if the Army and Navy give the word.

Such examples, of course, do not mean that our planes are often found inferior in operation. When they are superior it shows up in the total of enemy planes shot down, and the enemy designers have to do the worrying. But everybody, ourselves included, has to be ready to make necessary adjustments, on pain of falling behind in the race which will decide the future course of history.

The foregoing is a bird's-eye view of the design process as a whole. We may now consider some specific features of current airplane design. There has been a great deal of popular discussion on liquid-cooled *versus* air-cooled engines. Much of it has been based on incomplete technical information. It is true that the liquid-cooled motor, with the cylinders arranged in line, has a smaller cross section or frontal area than the air-cooled radial, with the cylinders arranged like the spokes of a wheel. Consequently the in-line motor can be buried in the airfoil or fuselage, and its nacelle can be made slimmer. But the smaller assembly is not necessarily more efficient, since, as we have seen, air must still be led to the engine for cooling purposes. All engines are air-cooled, some directly, others indirectly through a liquid coolant. Excellent planes can be designed with either type, and neither is standing still. American factories are now producing fine liquid-cooled engines of the Allison and Rolls-Royce Merlin types, generating 1,300 h.p. and more. At the same time a modern radial rated at 2,000 h.p. has the same diameter as a 1927 radial rated at 525 h.p., and less drag because the cowling shape has been improved. A good index of engine efficiency, from the aerodynamic standpoint, is pounds per horsepower, and we now have both in-line and radial motors running to little more than one pound per horsepower, and sometimes less than one pound. At the present time practically all bombers and large planes of American manufacture are powered with air-cooled radial engines, while about 50 percent of the fighters use liquid-cooled motors. Numerically, therefore, the radial is still far in the lead. A recent important advance in manufacture of radial motors is the forged cylinder head developed by the Wright Aeronautical Corporation, as reported in a previous issue of this magazine.

Engines are getting bigger in power if not in size. A few years ago a 450-h.p. engine was considered a whopper. Now engines of this rating are installed in advanced trainers. Engines now run between 1,000 and 2,000 horsepower; some of the British Stirling bombers are said to be powered with 1,600-h.p. units. At first, liquid-cooled engines were built in one line; when additional cylinders were needed for higher power another line was added, giving the familiar V arrangement, usually with 12 cylinders. But two lines or banks is not necessarily the limit, and there are already in-line engines with 24 cylinders developing 2,000 horsepower. The Germans are said to have a 3,200 h.p. Mercedes-Benz engine. The advent of much larger motors is foreshadowed by a torque tower at Wright Field, designed to accommodate engines as large as 8,000 h.p. for tests. According to Major de Seversky, research is actually proceeding on an engine of this power rating.

For cargo carrying, whether bombs or freight, larger aircraft are essential. There is economy in size: ton-mile cost varies in inverse ratio to the size of the plane. The necessity for more powerful engines to power the mammoth planes of the future



Molded plastic plywood is replacing precious metals in the construction of trainers and some other types of planes. Here workmen join halves of a fuselage molded by air pressure in the Vidal process

is illustrated by the Boeing B-19, powered at present by four Wright Cyclone 18's rated at 2,000 h.p. each. The Martin Mars has the same power plant and about the same gross weight. A total of 8,000 h.p. is insufficient for planes of this size—about 70 tons gross. The criterion is the factor known as power loading, which is the gross weight of the plane divided by the total horsepower. The lower the pounds per horsepower, the more adequately the plane is powered, and, other things being equal, the faster and higher it can cruise. At 140,000 pounds and 8,000 h.p. the B-19 has a power loading of 17 pounds per horsepower. This may be compared with the C-53 cargo carrier of the Air Service Command—25,200 pounds and 2,000 h.p., or 12.5 pounds per horsepower, which is an average figure. The present power loading of the B-19 is no more than that of a small civil aircraft or primary trainer. Obviously both it and the Mars are waiting for 4,000-h.p. engines, which would bring them down

Trend toward bigger planes is illustrated by the Boeing Sea Ranger, experimental long-range flying boat built for the Navy. In the weight class of four-engine planes, it is powered by two Wright Cyclones

to 10 pounds per horsepower, or about the same as the present Stirling bomber.

In some of their engines the Germans have dispensed with the carburetor. Using straight injection, they claim a 10-percent power increase, with less valve trouble and tendency to knock. On both British and German engines sleeve valves, which operate with a uniform motion and afford better timing control at high speeds, are being substituted for poppet valves. But the biggest prospective innovation is the use of Diesel fuel in place of gasoline for the engines of cargo planes. Some of the German Condors, which used to fly between Dakar and Natal, Brazil, are said to have been equipped with Diesels. One writer estimates that a cargo plane with four 2,000-h.p. engines and a load capacity of 17,500 pounds could increase its cargo load by over 6,000 pounds, or 35 percent, by changing from 90-octane gasoline to Diesel fuel. Among more remote engine developments, there is the gas turbine, which would minimize cooling problems, and possibly a steam engine for airplanes.

The prospect of more powerful engines brings up the propeller question. An engine is no good in itself; it must push or pull the plane through the air by means of a

Typical of all-around improvement in planes is the "ice-grip tread" designed for tires by the U.S. Rubber Company. Sharp, cylindrical crimped steel inserts in the tread prevent skidding on glare ice of fields in northern areas

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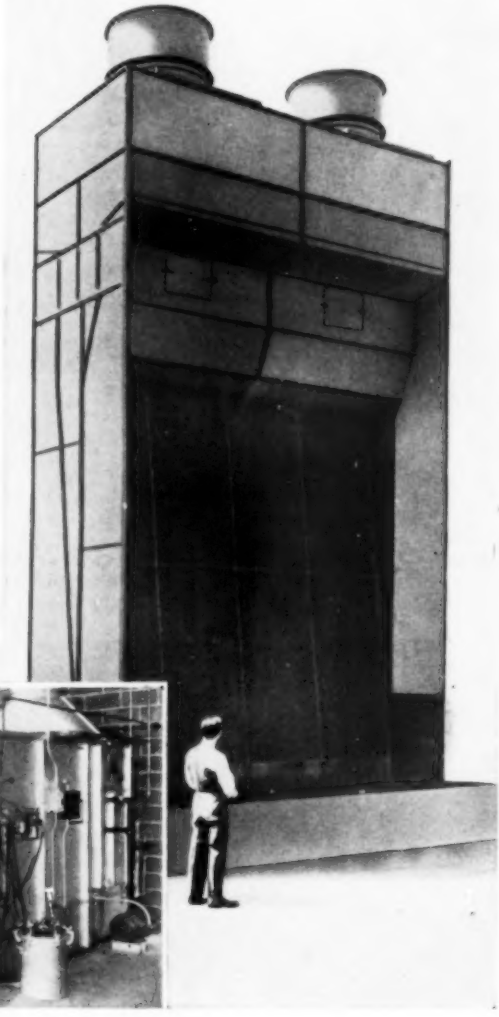
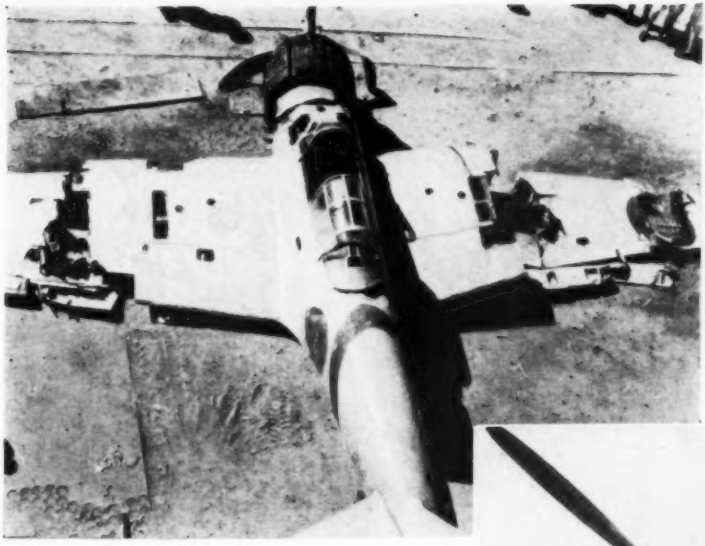


Spray booths grow up along with planes. At far right is one of eight compartments that will be assembled into an installation into which a big bomber can be rolled for spraying. Compare it with a standard spray booth seen in inset



Japanese Zero fighters sacrifice speed, armor protection, and structural strength for extreme maneuverability. Specimen at left was captured near Port Moresby, New Guinea, when it ran out of gas and had to land

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At the other extreme is our P-47, into which the designers have packed the most of everything they had—speed, armor, guns, structural strength. And maneuverability is there, too. Note the four-blade propeller on this fighter

propeller or some equivalent device. The problem of absorbing even currently available engine powers with airscrews of reasonable size is already acute. The Mars has propellers 17 feet 6 inches in diameter, and an 18-foot Curtiss-Wright propeller is being flight-tested by the Navy. The two-bladed airscrew is entirely inadequate for propelling large aircraft and is now found only on small, light planes. The minimum number of propeller blades for heavy planes is three, and a good many require four. The Martin B-26 medium bomber and the Republic P-47 fighter both mount four-bladed hollow steel propellers. In England contra-rotating airscrews are extensively used and their adoption on American planes is expected. Two three-bladed propellers, driven through coaxial shafts, give some help in absorbing the available power of the larger engines, without adding unduly to the diameter or the tip speed. But more radical remedies may have to be tried. Some designers believe that the tractor propeller will go into the discard entirely. Pushers, which were originally used, may come back because they appear to afford a faster climb rate and have certain aerodynamic advantages at very high speeds. Another proposal involves propulsion systems adapted to altitude. At a speed of 500 m.p.h. a three-bladed propeller 11.5 feet in diameter will absorb 3,000 h.p. efficiently. At 40,000 feet the same propeller will absorb only 450 h.p. Perhaps the ultimate answer is to have several engines driving one propeller at sea level, while at high altitudes each engine may drive several propellers.

The Airacobra also boasts of a novelty in the line of fire power—a 37-mm. cannon which fires an explosive shell. For some reason the British have substituted a 20-mm. cannon for the larger caliber in the Airacobras delivered to them. This is counter to the trend, *(Continued on page 223)*

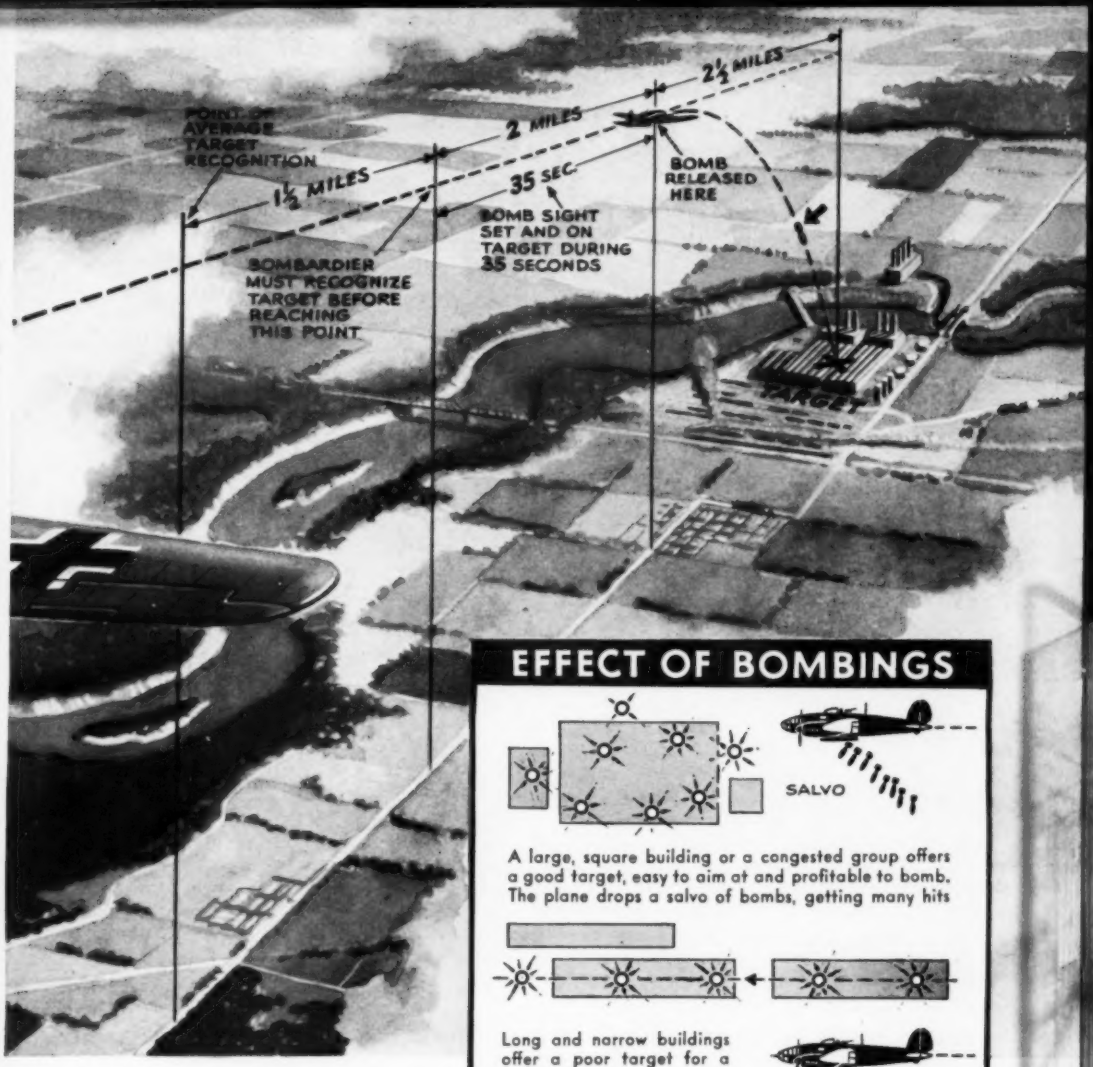
STEWART ROUSE

Putting Blinders on

INDUSTRIAL CAMOUFLAGE HAMPERS ACCURATE

INDUSTRIAL camouflage is the recapture of the light, shadow, and contours of nature which have been destroyed by the industrialist's passion for efficiency and his conviction that a straight line is the shortest distance between two points. The purpose is to make a rectangular building or a group of buildings melt into the surrounding countryside as viewed by airplane pilot, to muffle their sharp contours and shadows, to dull reflections and to disperse targets.

"Successful camouflage," say Konrad F. Wittmann, German-trained architect, and James C. Boudreau, director of the Pratt Institute Camouflage program, in the "Industrial Camouflage Manual," "is never the result of tricks or mystification. Study of nature, repeated observation and an ability to 'build' three-dimensional effects are necessary premises for good camouflage work. The art of the painter is two-dimensional. He may, by clever contrasts, deceive the close



the Axis

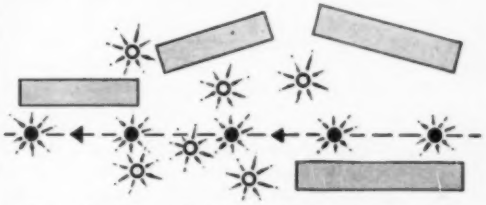
BOMBING RAIDS

***THIS ARTICLE** is based upon the "Industrial Camouflage Manual," a report on the work of the industrial camouflage program at Pratt Institute, Brooklyn, N.Y., by Konrad F. Wittmann in collaboration with the faculty. It is illustrated with diagrams, drawings, and photographs. Published June 1942, Reinhold Publishing Corp., New York.*

EFFECT OF BOMBINGS

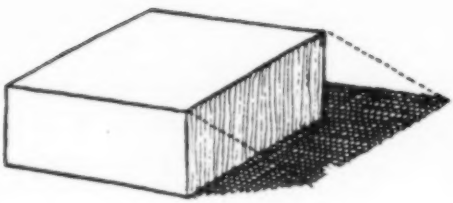
A large, square building or a congested group offers a good target, easy to aim at and profitable to bomb. The plane drops a salvo of bombs, getting many hits

Long and narrow buildings offer a poor target for a salvo, but they are vulnerable to a stick of bombs. The long extension makes an easy target for a series of blasts in a straight line

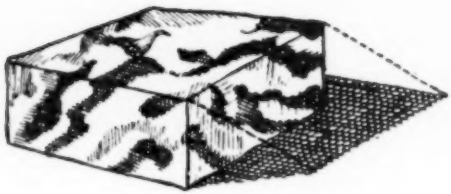


For protection against both salvo and stick bombing, the best arrangement for industrial buildings is a group of moderately long structures, not in a line

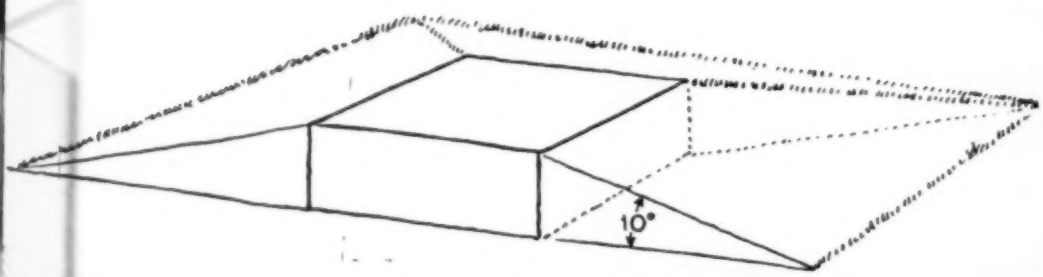
PRINCIPLES OF INDUSTRIAL CAMOUFLAGE:



Installations of regular geometrical shape are easily identified by the bombardier, because of their straight shadows and the contrast between their contours and the surrounding natural objects



"Disruptive painting" with strong contrast breaks the regular outlines and so confuses the perception of form. However, it is ineffective from a great height because the straight shadow remains



A sure way to eliminate shadows completely is to grade the terrain up to the roof level at an angle no greater than 10 degrees. With this treatment, the object is hardly noticeable from the sky, especially if the roof is given a texture to match the surroundings. If grading is impractical, a somewhat similar effect may be obtained by stretching nets from the top of the building to the ground at a 10-degree angle

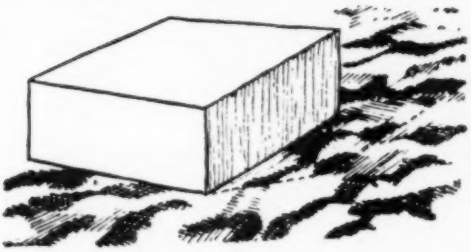
observer into believing he sees a relief. This illusion does not hold true for 5,000 feet, however. Real shadow is, at a great distance, much more effective than any painted shadow. Camouflage has been declared an art, like that of the painter, but reversing his principles. This is false; we cannot suppress form with paint, nor fight real shadow with painted light. Every observation of nature reveals a composition of light, self-shadow, and cast shadow. An artificial reproduction of nature must compose similar elements—parts which catch light and others which absorb shadow."

The devices which have been found effective from the air often look fantastically prominent from the ground. Roofs, skylights, chimneys, and silos are betraying symbols to the aviator and their outlines must be protected from above, while their shadows must be destroyed or blended inextricably with other shadows.

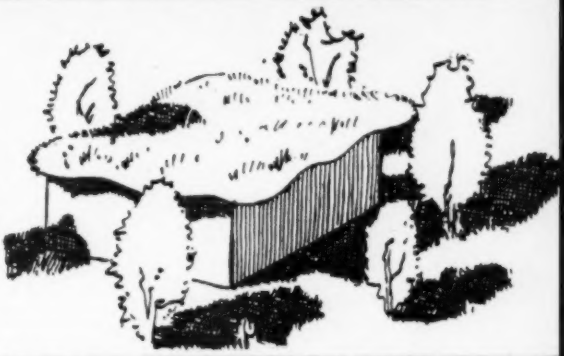
Rectangular roofs are made irregular in outline, their new shapes blending if possible with the contours of the ground and the patterns of neighboring patches of woods. These irregular roof surfaces are covered with artificial sod or brush or, if there are essential skylights—a treacherous convenience in territory liable to air raids —by nets dappled with irregular patches impervious to light. The "sawtooth" factory roof, also a landmark for bombers, may be protected by nets and projecting penthouses which shade the glazed side.

However effective the roof disguise may be, ground shadows will remain and are easily identifiable by the bombardier. By setting out trees and shrubbery at strategic points, however, a whole pattern of ground shadows is laid, into which the shadow of the building will merge. Grading the surrounding land on a 10-degree slope up to the roof of the building will make it virtual-

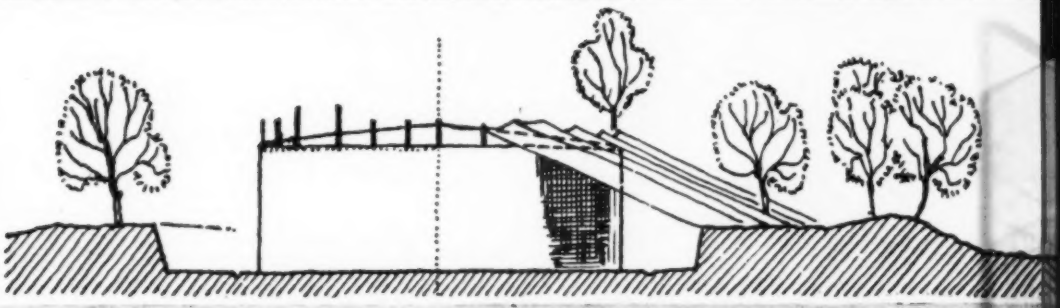
JUGGLING SHAPE, SHADOW, AND TEXTURE



A pavement of dark and white material in an irregular pattern around the base distorts the shadow to a certain degree. This time it is the shape that remains as a telltale sign for the bombers



A projecting roof of curved shape shadows vertical walls and distorts the rigid geometry of light and shade. Grass planted on the roof gives texture to match surroundings. Trees aid concealment



A storage tank is concealed by nets stretched between its top and the surrounding embankment, making an irregular formation of lines and slopes. Nets should not be regularly round like circus tents. Trees set around the tank help to hide it, and whole trees may be placed on top temporarily in special holders. The embankment, designed to catch contents if tank is hit, should be irregular to avoid concentric circles

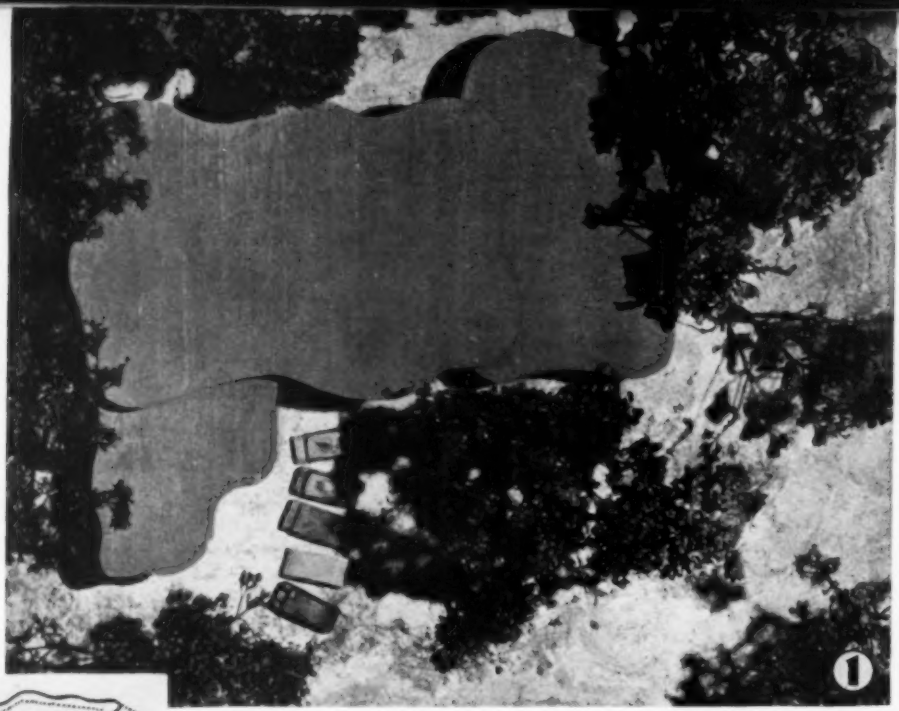
ly shadowless as viewed from the air. Shadows may be reduced also by terracing the ground up from the base of the walls.

When a new plant is being erected or new buildings added to one already in existence, the resulting pattern is highly important for security's sake. If the buildings are bombed it will be either by salvo or by dropping a stick of bombs. In the former case, the bombs are dropped singly in a pattern intended to cover the entire industrial area. In the latter case, the bombs fall in a straight line. If the plant buildings are long and narrow, stick bombing is the more likely. It is recommended, therefore, to put up new buildings in an offset pattern, so that they will not be in line and will stand a greater chance of escaping damage whichever type of bombing is used.

Railroads and highways act as guides for bombing aviators and it is recommended that they be concealed so far as possible in the vicinity of important plants. Streets which come to a dead end at the plant area are so many arrows pointing out the target to the bombardier. Concealment by natural or artificial trees is suggested.

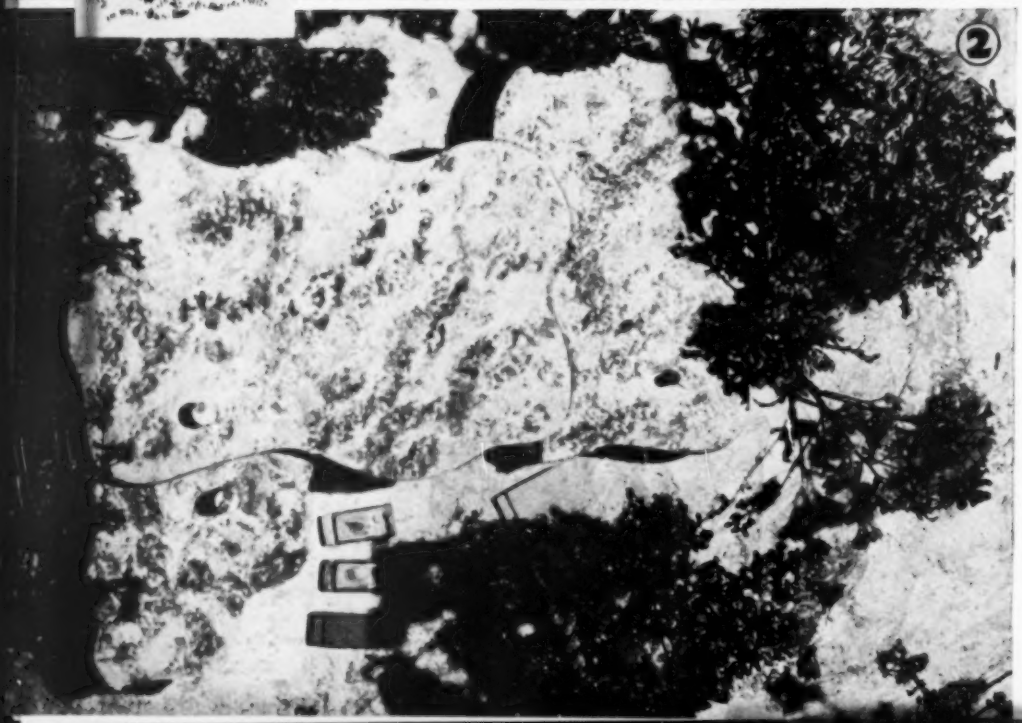
As developed in the drawing at the head of the story, the bombardier has approximately only 35 seconds in which to get his bomb sight set on the target. He generally is within six miles of his target before he can recognize it. Within the next mile and a half he must recognize it, or he will not have even 35 seconds in which to set his sight, for, at average bombing height and speed, he must release his bombs when still 2½ miles from the target.

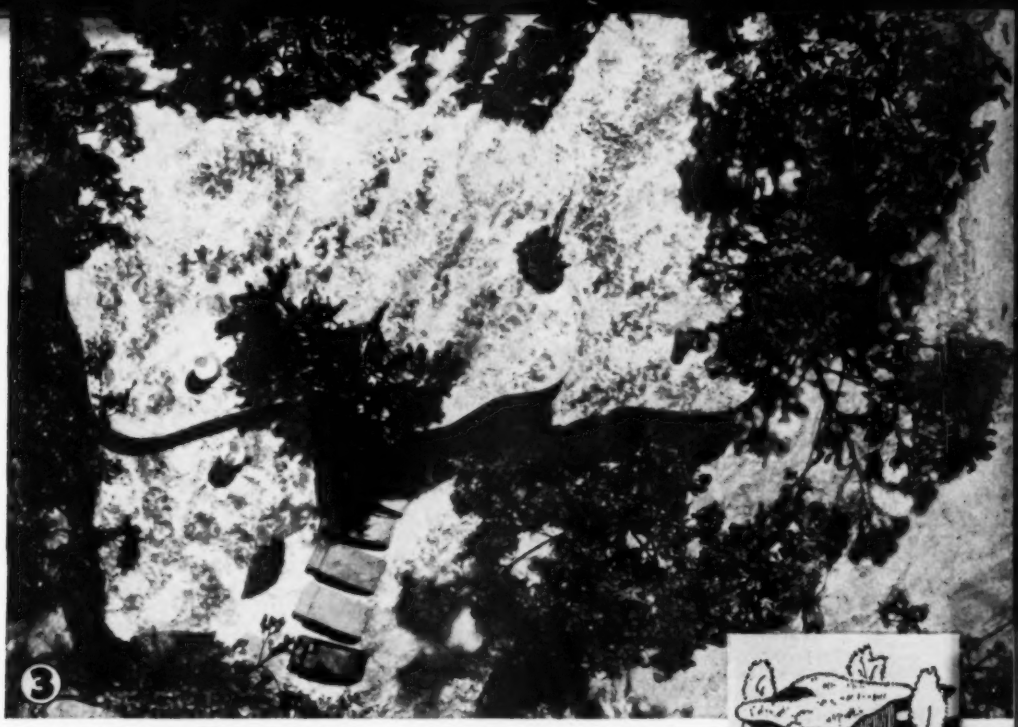
It is therefore at a man from 2½ to six miles away and two miles or more up in the air that industrial camouflage is directed. It may look silly enough to the observer on the ground and still be effective so far as the air observer is concerned. *(Continued)*



"Aerial photographs" of models show how buildings vanish under the magic of camouflage. Above, the angular shape of a building has been hidden by a roof of curved shape. This device is specially effective in a setting of rounded hills and trees

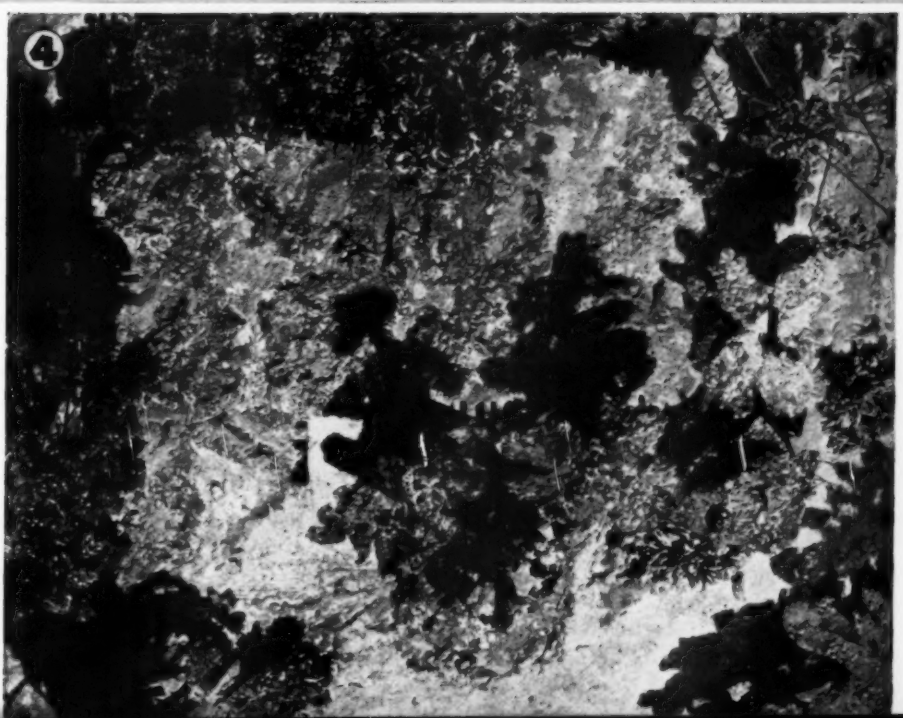
Here the serpentine roof has been textured to simulate grass. This texture can be obtained by spreading excelsior, wood shavings, or rubbish. Spreading trees surround the building, their round shadows blending with the shade cast by the walls





Shrubs placed on the roof, with quick-growing weeds or higher heaps of artificial texture, add to the confusion of shadows. The round shadows resemble shade cast by rocks. The cars might still give the place away if not parked in the shadows

This is a vertical view of the same building, with artificial trees placed to throw their shadows on the roof. On the scale model, these shadows look solid, but on actual installations they can be feathered out. The trees are supported by dark guy wires, which are invisible against any terrain



SPECIALIST CORPS FORMED

Army Seeks Highly Trained Men to Free Others for Fighting

POSSIBLY you are a metallurgical engineer, a business man skilled in personnel management, a transportation expert, or perhaps you are trained and experienced in any of a number of other professions. If so, the chances are the Army may have a place for you in its recently formed Specialist Corps.

This is an organization of uniformed civilians which will play an active part in winning the war. It is for men skilled in science, engineering, technical work, or business administration, but unlikely to be called for military service because of family dependence or minor physical defects. The most important qualification for members is proved ability.

While most of the men taken into the corps will have duty with the services of supply, many will be assigned to tactical organizations in the United States and in the overseas theaters of operations. They are not to do any actual fighting, but some of them are likely to see service close to the fighting fronts.

The corps is a branch of the War Department headed by Director General Dwight F. Davis, former Secretary of War and former Governor General of the Philippines. Its job is the procuring of the most skilled men available to fill thousands of Army jobs which do not require military training and experience, but which do demand outstanding ability in varied fields of civilian activity. It is highly probable that Specialist Corps members will soon relieve, and release for purely military duties, many officers now filling administrative or technical positions in Washington, D. C., and elsewhere.

The organization was set up on the recommendation of Gen. George C. Marshall and the General Staff. The chiefs of the various branches of the Army have been directed to submit reports of the vacancies in their organizations which can be filled with specialists, and all commanders of tactical and administrative units are being encouraged to requisition specialists for appropriate positions in their commands.

BUY WAR SAVINGS BONDS AND STAMPS

The initiative for using specialists in any of the special jobs will come from the Army itself. While rosters of qualified men are being built up for the purpose of filling future requisitions, no appointments are being made or enlistments accepted, except on the request of the Army to fill definite vacancies. At present the emphasis is on the appointment of officers. No enlistments are being accepted for service in the United States, and few for service overseas. It is probable, however, that in the near future recruiting of the higher grades of enlisted specialists for overseas service will be started.

As the work of the corps becomes more widely known to the Army in the field, increased numbers of requisitions will be made on it, and new skills will be added to the list. Many specialists, according to the belief held by Army men, will be used to fill important technical positions in motorized and air units.

The Army Specialist Corps is a semi-military organization. Its distinctive insignia consists of a silver eagle on a burgundy-colored background for collar and cap and a burgundy-colored sleeve braid. The design of the eagle differs from that of the one used in the Army itself.

Officers and enlisted specialists wear the same rank insignia and grade chevrons as Army officers or enlisted men of equivalent rank or grade. Discipline approximates military discipline. While specialists remain members of their corps during their entire service, they are directly responsible to the military commander of the organization in which they are serving and are under his orders.

They do not exercise the command of Army officers, but when Army personnel is assigned to duty in any activity operated by officers of the corps, the Army men are subject to the orders of the corps officers to the same extent as if they were members of the corps.

Selective service registrants who are at all likely to be called for military service are not eligible for the Specialist Corps, but men with needed skills who are over 30, have been classified 3A, and have several dependents, are being accepted, as are men under 30 who have been classified 4F because of physical faults which do not impair their particular skills. Applicants must undergo a flexible-type physical examination. For service in the United States, physical ability to do the designated work is the passing standard; for service overseas, a 1-B standard or higher must be attained.

Specialist Corps officers are appointed to ranks ranging from second lieutenant to colonel. Specialists are enlisted in five grades ranging

MEN WANTED: UNCLE SAM ISSUES CALL FOR EXPERTS

The Army needs men skilled in almost every profession, business, and trade. Whatever your job is, if you are extra good at it, you may be wanted. Here are some of the posts now being filled:

PROFESSIONS	WHERE SERVICES ARE REQUIRED
ENGINEERS AND PRODUCTION MEN	Electrical engineers in Signal Corps and other branches (urgent). Mechanical engineers in Ordnance Department and other branches. Metallurgists and metallurgical engineers in several branches. Some sanitation and public-utility engineers. Probably some draftsmen, inspectors, supervisors, foremen, and other skilled men for production, especially metal fabrication, and maintenance work.
CHEMISTS	Chemical engineers and chemists in Chemical Warfare Service and other branches.
COMMUNICATIONS MEN	Radio, telephone, and telegraph engineers, and others in Signal Corps and other technical branches. Radio maintenance men and telephone and telegraph operators (heavy demand).
TRANSPORTATION MEN	Railroad traffic and operating executives and other experts in various branches (urgent). Air-transport executives and other air experts in Air Corps and other branches (urgent). Experienced truck-fleet operation and maintenance men in Quartermaster Corps (urgent). Some water-borne transportation men.
BUSINESS MEN, BANKERS, AND LAWYERS	Personnel, office, and finance executives, and clerical supervisors in administrative posts in ground and air forces. Some economists, foreign and domestic-trade specialists, and lawyers. Wholesale and retail executives, especially with food, textile, and clothing experience, in Quartermaster Corps. Men with retail and chain-store experience as post-exchange officers.
ACCOUNTANTS	Accountants, auditors, and statisticians in several branches.
WAREHOUSEMEN	Experienced men for Army depots.
MISCELLANEOUS	Many men for censorship work—those speaking a foreign language especially valuable.

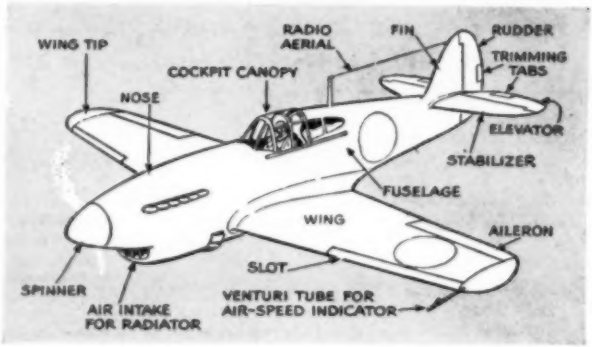
ARMY SPECIALIST CORPS PAY RATES

OFFICERS		ENLISTED SPECIALISTS	
Colonel	$6,500	Specialist, 1st Class (master sergeant)	$2,900
Lieutenant Colonel	5,600	Specialist, 2nd Class (technical sergeant)	2,600
Major	4,600	Specialist, 3rd Class (staff sergeant)	2,300
Captain	3,500-3,800	Specialist, 4th Class (sergeant)	2,000
First Lieutenant	3,200	Specialist, 5th Class (corporal)	1,800
Second Lieutenant	2,600-2,900		

from corporal to master sergeant. Appointments and enlistments are for the duration and six months thereafter, except that for some special work short-term appointments may be made. All members are subject to assignment for duty with the Army anywhere in the United States or in any theater of operations. Their exact stations are determined by the commanding officer of the organization to which they are assigned.

If you can do a job really well, there is a chance that the Specialist Corps will be able to find a place for you. Information may be obtained at any Army Information Center, or by writing Army Specialist Corps Headquarters, War Department, Washington.

How You Can Learn



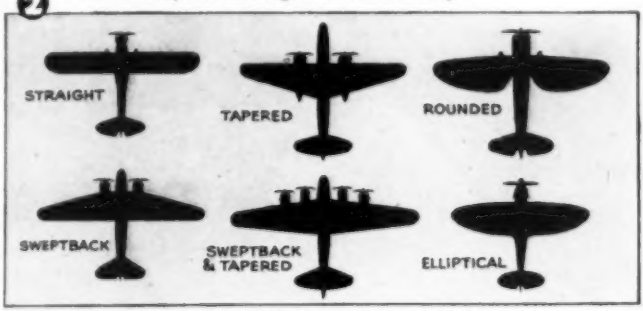
These are the component parts of a modern military airplane

ONLY constant training and practice will enable an observer definitely to classify airplanes, partly because the speed and great altitudes at which they fly usually make markings invisible. But five minutes' study of a few simple rules should make it possible for almost anyone to identify aircraft by type, and as a rule that is sufficient for all practical purposes.

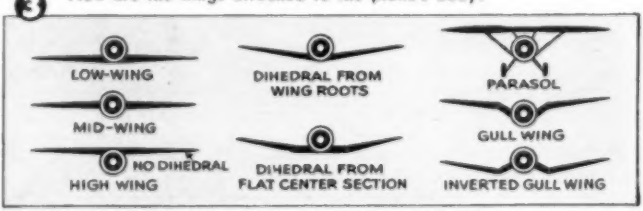
As a preliminary the observer should familiarize him-

1 In spotting a plane, first estimate its size. If it is large and multi-motored it is a bomber or transport. Blisters and transparent nose identify bombers. If it has only one motor and short stubby wings it is a pursuit ship or an observation plane

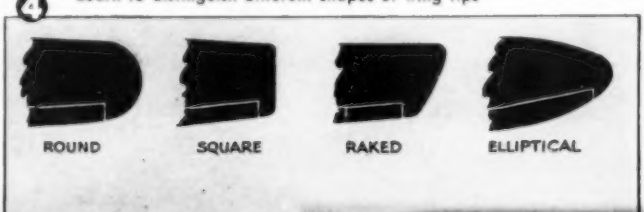
2 Note the shape of the wings. Here are six shapes



3 How are the wings attached to the plane's body?



4 Learn to distinguish different shapes of wing tips



in Five Minutes to Spot Planes

self with the silhouettes of friendly aircraft. Any plane not possessing typical and easily observed characteristics of these silhouettes is probably hostile and should be reported. The first thing to do is to look at the size of the plane. If it is large and has more than one motor, it is either a bomber or a transport. If the fuselage and wings are deep, it is a transport. If they are long and thin, if the fuselage is broken with blisters and the nose transparent, it is a bomber. If the plane has but one engine, and if the wings are stubby, it is a pursuit or observation plane. Another way to distinguish between pursuits and bombers is by sound and speed—pursuits travel faster and their motors whine with a high note.

Above all, learn to look for the differences of design and construction that distinguish one plane from another.

CHARACTERISTICS OF U. S. PLANES

P-38 Two motors, tapered wing, mid wing, rounded wing tip, pursuit cockpit, pursuit nose, horizontal tailplane connecting twin tail booms. (Pursuit).

P-39 Single motor, tapered wing, low wing, rounded wing tip, pursuit cockpit, pursuit nose, single fin and rudder. (Pursuit).

P-40 Single motor, tapered wing, low wing, rounded wing tip, pursuit cockpit, pursuit nose, single fin and rudder. (Pursuit).

A-20 Two motors, tapered wing, mid wing, rounded wing tip, bomber cockpit, bomber nose, single fin and rudder. (Bomber).

A-24 Single motor, tapered wing, low wing (dihedral from flat center section) rounded wing tips, observation cockpit, pursuit nose, single fin and rudder. (Scout Dive Bomber).

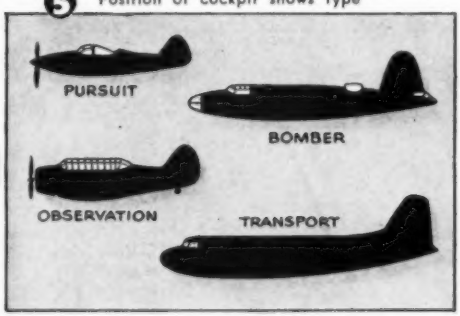
B-17 Four motors, sweptback and tapered wing, low wing (dihedral from wing roots), rounded wing tips, bomber cockpit, bomber nose, single fin and rudder. (Bomber).

B-24 Four motors, tapered wing, mid wing, rounded wing tips, bomber cockpit, bomber nose, double fins and rudders on horizontal tailplane. (Bomber).

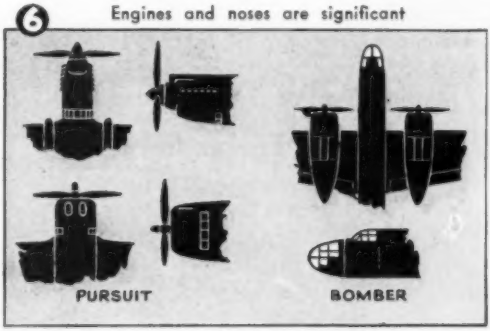
B-25 Two motors, sweptback and tapered wing, mid wing, rounded wing tips, bomber cockpit, bomber nose, double fins and rudders on horizontal tailplane. (Bomber).

B-26 Two motors, sweptback and tapered wing, high wing, rounded wing tips, bomber cockpit, bomber nose, single fin and rudder. (Bomber).

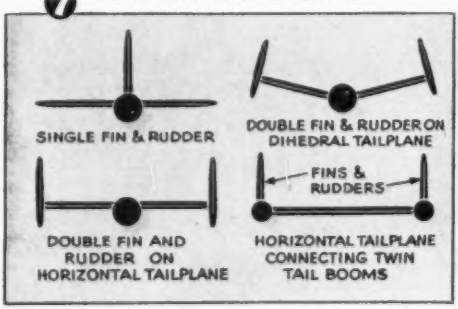
5 Position of cockpit shows type



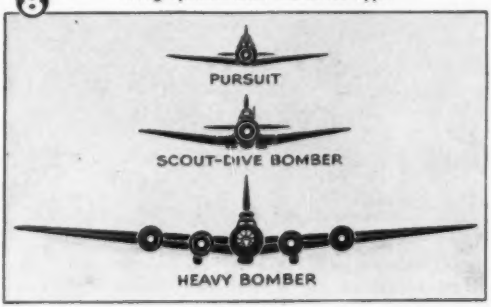
6 Engines and noses are significant



7 Notice construction of the tail


SINGLE FIN & RUDDER
DOUBLE FIN & RUDDER ON DIHEDRAL TAILPLANE
FINS & RUDDERS
DOUBLE FIN AND RUDDER ON HORIZONTAL TAILPLANE
HORIZONTAL TAILPLANE CONNECTING TWIN TAIL BOOMS

8 Wing spread also indicates type

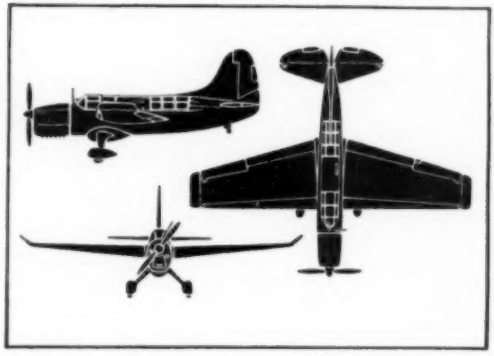


Fast Cruiser-Based Scout Plane Extends Navy's Range

Launched by catapult from a battleship or cruiser, the Curtiss Seagull (SO3C-1) can perform observation tasks at long range

Silhouettes show how the SO3C-1 looks from above, abeam, and dead ahead. It can operate with either floats or wheels. A V-type air-cooled engine powers this fast new scout craft

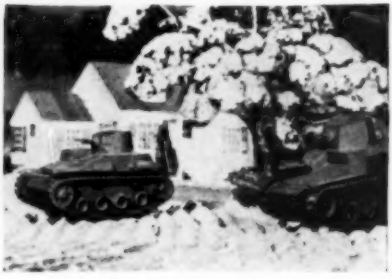
SHOWN above in flight is what its designers call the fastest battleship or cruiser-based airplane in the world. It is the new long-range Curtiss Seagull—officially designated the SO3C-1. These sleek scout-observation craft now are rolling off the assembly lines at the new Columbus, Ohio, plant of the Curtiss-Wright Corporation. The Seagull is designed to operate with either floats or wheels and to be launched by catapult. Its use will greatly extend the scouting range of the Navy. No details of its specifications or performance have been released.



Model Tanks Teach Soldiers How to Tell Friend from Foe

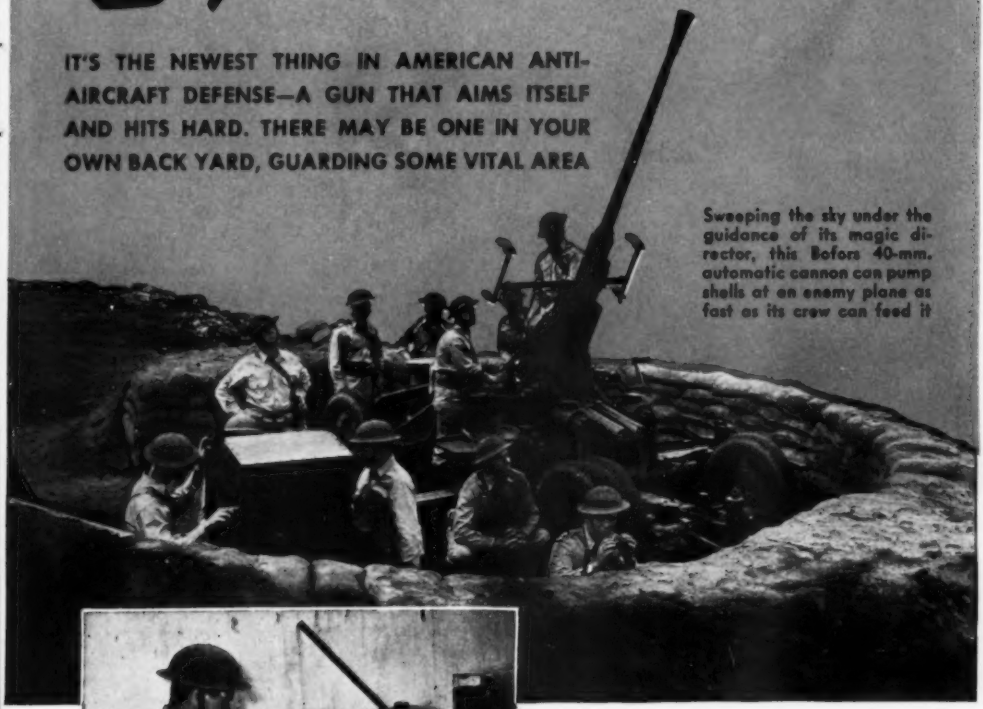
ARMY tank crews will now be able to distinguish friend or enemy tanks with more certainty, thanks to training with a "tank identification table" devised by Staff Sergeant Robert Zeidman at Fort Knox, Ky. Aided by his all-soldier staff, he builds exact models of all known types of tanks, which are set in a three-dimensional exhibit measuring 10 by 10 feet. Rods maneuver the tanks in a realistic setting artificially lighted to simulate real battle conditions.

Soldier-artists at Fort Knox, Ky., at work on model tanks for the "identification table." Moved by rods, the models maneuver in realistic settings as illustrated at right

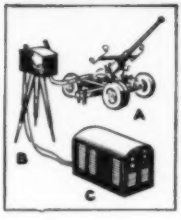


Largest of the Automatics

IT'S THE NEWEST THING IN AMERICAN ANTI-AIRCRAFT DEFENSE—A GUN THAT AIMS ITSELF AND HITS HARD. THERE MAY BE ONE IN YOUR OWN BACK YARD, GUARDING SOME VITAL AREA



Sweeping the sky under the guidance of its magic director, this Bofors 40-mm. automatic cannon can pump shells at an enemy plane as fast as its crew can feed it



Three units commonly make up the section: the gun itself (A); the director (B), a robot "lightning calculator" which can be used to aim the gun; and the portable gasoline-powered generator unit (C) supplying current for the tracking mechanism. The generator is seen in the photo above

By JOHN WALKER

SLANTING upward from carefully concealed positions spotted around our seacoast cities and industrial areas, sleek gun barrels with odd flared muzzles rake the sky. Around the guns, artillerymen stand always at the alert, ready to blast any enemy plane that may appear. Theirs is a powerful weapon against raiding planes—the Bofors 40-millimeter automatic cannon, hooked to a magic director mechanism that will hold the gun on a hostile bomber while it pumps shells as fast as the clips can be fed into it.

A neatly streamlined combat team, known informally as the "forty-fifty" has been organized recently for the specific job of guarding American installations against one of the most dangerous forms of air attack—low-level or dive bombing. The tag "forty-fifty" is entirely unofficial and comes from the fact that one defense section or emplacement has two supplementary weapons—the sleek Bofors 40-milli- *(Continued)*

DIRECTOR AIMED FIRE

When the director is in use, the gun crew has nothing to do except feed in clips of cartridges and fire the piece. The barrel is aimed for both elevation and traverse by two sets of electric motors, one in the director and the other in the gun mechanism. The crew is trained for split-second teamwork

With director aiming, the gun is fired by a foot trigger operated by the man seen standing on the carriage in the photograph above. He uses his left foot

At the director, two men track the target through telescopes, one for elevation, the other for traverse. The firing data thus obtained are transmitted electrically to the gun's aiming mechanism, where gears and wheels elevate and turn the barrel accordingly

MANUALLY AIMED FIRE

WHAT THE GUNNERS SEE. For manual aiming, a gunner looks through each of these sights and turns a crank which moves the gun until the cross hairs of the sight are on the target plane, as illustrated above

The Bofors takes its shells in clips of four, which are fed into the breech from the top. In this it differs from the 37-mm. antiaircraft gun, which uses clips of ten and feeds from the side of the breech

Here is the crew in position for manually aimed fire. The gunners are seated on opposite sides of the breech, with their eyes to their sights. The man at the right in the picture is handling the elevation control, the one at the left the traverse. Note sleek, tapered barrel, flash hider at end

Control mechanism on the elevation gunner's side of the gun is shown at the right. The gunner raises the barrel by turning the double-throw crank with both hands. The traverse gunner on the opposite side of the piece uses a similar crank to turn the barrel from side to side

This time the gun is fired by a treadle operated by the elevation gunner. A special feature of the Bofors is a barrel-assembly mounting which permits a new barrel to be substituted quickly for one that has become overheated

meter automatic cannon and the blunt, ugly, efficient .50 caliber machine gun.

In action the Bofors gun blasts its deadly load of steel and high explosive at the attacking bombers diving in or coming over for a bombing run at low level. The .50 supplements this fire and protects it against enemy planes which sneak in for a strafing attack at extreme low altitude. It also pays particular attention to any angle of fire that the bigger gun might have trouble covering because of the terrain or near-by structures.

The Antiaircraft Artillery Command of the Eastern Defense Command permitted a writer and photographer for POPULAR SCIENCE to visit a typical "forty-fifty" section soon after it had been set up at a secret location somewhere on the U. S. coastline.

Two officer-guides passed us by an outer gate manned by watchful sentries and led the way down to the emplacement, carefully concealed from any shoreward angle of view. The position is planned so that you don't even see the guns until you are almost on top of them. Then you pass the snub-nosed machine gun and come on the Bofors, certainly one of the war's most functionally beautiful weapons, with its slender, tapering barrel and the graceful flare of the flash-hider at the muzzle. There a husky young antiaircraft-artillery lieutenant took over and staged a demonstration drill with the gun crew.

These men are on battle stations at all times, just as much as though they were stationed in Australia, Ireland, or any other part of the world where U. S. forces have been sent. They were businesslike and soldierly, and ran through their drill with a snap and precision that were good to see.

They were part of a Separate Coast Artillery Battalion (Antiaircraft). This originally was a southern National Guard outfit, and the soft southern drawl was still noticeable among the men, even though the personnel has shifted considerably and many replacements were northern and midwestern boys.

First they ran through the drill with a full crew on and two men aiming the gun by direct observation. Then the gun was switched over to automatic control with a costly, intricate director mechanism doing the aiming. Afterward the lieutenant began asking some informal questions and soon had the men going strong and not even attempting to conceal their pride in the section's new equipment.

The gunners had only recently graduated to the 40-mm. gun, after doing most of their training on the 37-mm. automatic antiaircraft cannon. The two guns have many similarities and perform much the same mission. The Bofors 40, originally a Swedish design and later taken over by the British, has now been modified slightly to line up with American manufacturing practice and is being mass-produced for our own forces. The men made it clear they hadn't fallen out of love with the old 37, but regarded the 40 as a more advanced gun with a stiffer punch. The difference in caliber is slight, but the 40-mm. shell is appreciably longer and heavier than the 37.

The Bofors, like the 37, is an automatic gun, but takes its shells in clips of four instead of 10, and feeds them into the breech from the top instead of from the left side as in the 37.

Every shell is a tracer, to help correct aim during fire, and the high-explosive shells are fitted with a supersensitive nose fuse which operates at the slightest contact with any part of a plane's surface, bursting the shell into a deadly mushroom of steel fragments.

"Tell you how good that fuse is," a corporal remarked. "We could shoot one into a cardboard shoe box, and the shell would go through one side of the box and blow inside it, before it hit the other side." The sergeant nodded.

"But the best thing about this gun," he added, "is the way you can change barrels. This whole barrel assembly is mounted with an interrupted thread. All we need is two wrenches and a quarter turn—you can have the old barrel off and a new one on in 30 seconds or less."

"If you had enough planes to fire at," the lieutenant grinned, "I guess you'd shoot until the barrel curled right up anyhow."

A typical "forty-fifty" section will have a sergeant in charge. When in action, two men are on the machine gun, a corporal and five men on the Bofors, and a corporal and two men on the automatic director. There are four of these sections to a platoon, two platoons to a battery, four firing batteries and a headquarters battery (actually an administrative staff) to a battalion.

Each gun has its own director. This might seem like extreme duplication of the intricate director equipment, but it pays our Army rich dividends.

"The first time we fired with the director at a sleeve target towed behind a plane, the first burst blew the sleeve right off, and that was that," a lanky private said.

At this post, both gun and director were mounted in a shallow pit carefully protected by a circular embankment of earth and sandbags. The gun was on its special mobile mount, the director box on heavy shock absorbers.

Some features of U. S. gunnery directors

The "fifty" end of the "forty-fifty" team is a squat, ugly .50 caliber antiaircraft machine gun. It protects its big brother against strafing attacks and takes care of angles of fire the Bofors cannot cover

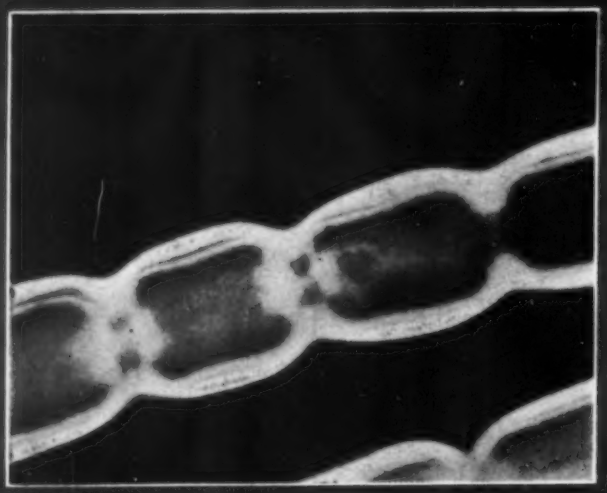
are closely guarded military secrets. The basic principles of the device, however, are well understood in all armies. Actually the director is a fast-operating robot with precise, intricate mechanism designed to work out almost instantaneous answers to artillery problems of mathematics and to transmit those answers mechanically to the gears and wheels which elevate and traverse the gun barrel.

On the director two operators follow the path of the target plane with telescopes. One tracks the plane across the field of vision, the other up and down. They keep the crossed hairs of the 'scopes on the plane by turning small crank handles which move the telescope and transmit the data continuously to the inner mechanism. After fire has been opened, the path of the tracer shells makes it relatively simple to add any necessary correction.

The director also is constructed so that it adds certain corrections of its own to the automatic-firing data. The result is that the gun is aimed, not to where the men see the enemy plane, but to where it will be when the shot has been fired and the shell arrives at the right altitude.

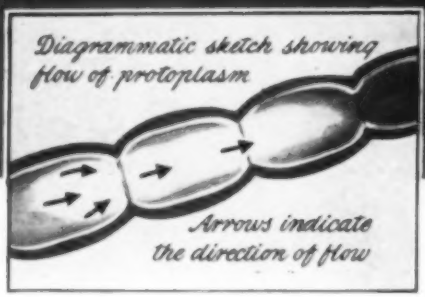
Transmission of the calculated data from the director to the gun is accomplished by means of two sets of synchronized electric motors—one set in the director box and the other in the gun mechanism. These motors are small bipolar three-phase alternators, the stators of which are excited from a common source of electricity—the director's own gasoline-operated generator. All angular displacements of the rotors of the transmitter motors in the director are instantly duplicated in the corresponding receivers at the gun.

Gun crews are on duty night and day, and the men who operate the director are busiest of all, drilling incessantly to perfect their teamwork. There are few periods during the daylight hours when aircraft are not in sight at this position, and every plane is tracked with the director as long as it remains in sight. Some day a plane may come along with the Nazi black cross or the Jap red ball on its wings, and if that happens the "forty-fifty" men will be ready.

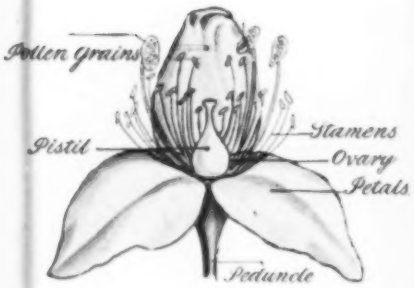


Plant

AMAZING PHOTOS SHOWING A FLOW OF LIFE STREAM IN DYE-INJECTED LIVING BLOSSOMS PROVE DISPUTED BIOLOGICAL FACT



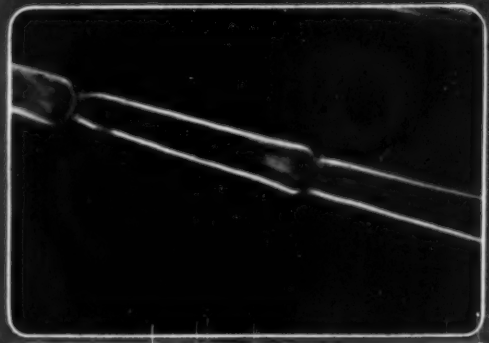
CELLS IN THE STAMEN FILAMENT of the blossom of a tradescantia, or spiderwort, are enlarged 250 times in the color photomicrograph at the top of the page to show the protoplasm within their walls. The drawing indicates the protoplasm's flow as revealed by Dr. Pillsbury

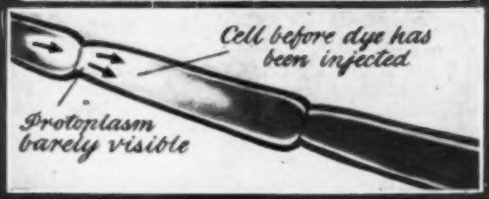


BLOSSOM OF THE TRADESCANTIA

This is the short-lived flower of an American herb. The drawing above shows the hairy stamens surrounding the center of the blossom. It was from one of these stamens that Dr. Pillsbury selected a filament to make the photomicrographs of cells and protoplasm on these pages, cutting it off near the base of the pistil

NATURAL CELLS of the stamen filament of the tradescantia are shown below. Between the cells are thin partitions through which, Dr. Pillsbury finds, living protoplasm will filter in surges





Cells Swap Protoplasm

WITH the aid of a high-power microscope and a lapse-time camera, Dr. Arthur C. Pillsbury, a botanist of Berkeley, Calif., has been able to convince scientists that protoplasm actually passes from one cell to another in plant life—a fact that has been disputed in botanical circles.

In demonstrating the movement of protoplasm between plant cells, Dr. Pillsbury takes the blossom of a tradescantia, or spiderwort, and cuts off a stamen filament near the base of the pistil. He then mounts the specimen on a microscopic slide and carefully injects a brown fruit dye into the wall of an individual cell. Thus making the protoplasm visible, he is able to watch the dyed, jellylike substance move.

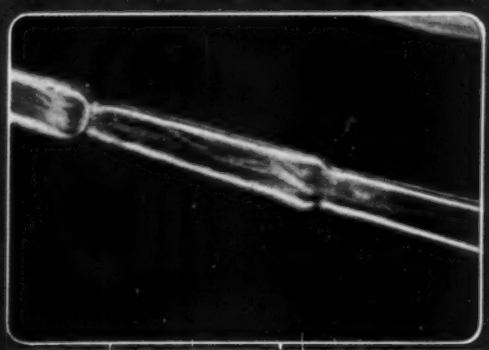
Although each partition between the individual cells seems to wall the protoplasm from the next cell, a small amount filters through with each surge of the substance. Even high-powered microscopes do not show any visible opening between the cells but, according to Dr. Pillsbury, there must be minute openings which allow a small amount of the protoplasm through.

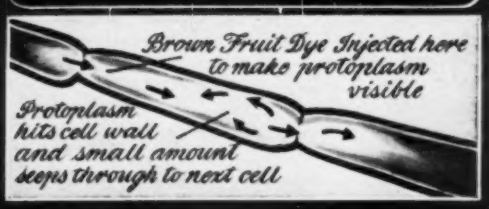
For example, explains Dr. Pillsbury, if you had a long string of macaroni that was soft and damp, and you tied a silk thread around every half-inch, you would have a scale model of the stamen filaments. If each unit or cell was filled with living protoplasm, it would act in the same way even though no openings were visible.

The first picture in the accompanying sequence series shows the cells before the dye was injected. In the second picture, the brown fruit dye was injected in the left corner of the middle cell and was allowed to mix with the protoplasm for the next five minutes. Notice how the jellylike substance has worked itself toward the right-hand corner. The third picture shows the protoplasm moving toward the end of the filament. While most of the substance has rebounded on the cell partition, a small amount is seen filtering into the third cell.

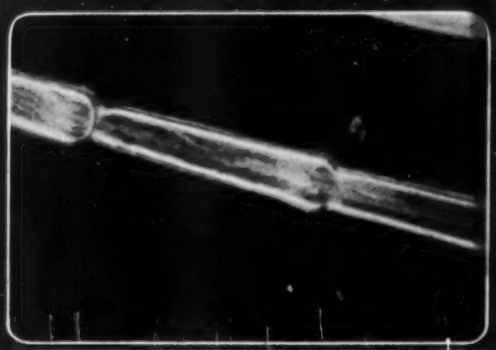
These photographs—taken for POPULAR SCIENCE by Dr. Pillsbury—were made in natural color under polarized light. Magnified 250 times their normal size, the tradescantia stamen cells were selected for demonstration purposes because of their clear-cut definition and adaption to polarization.

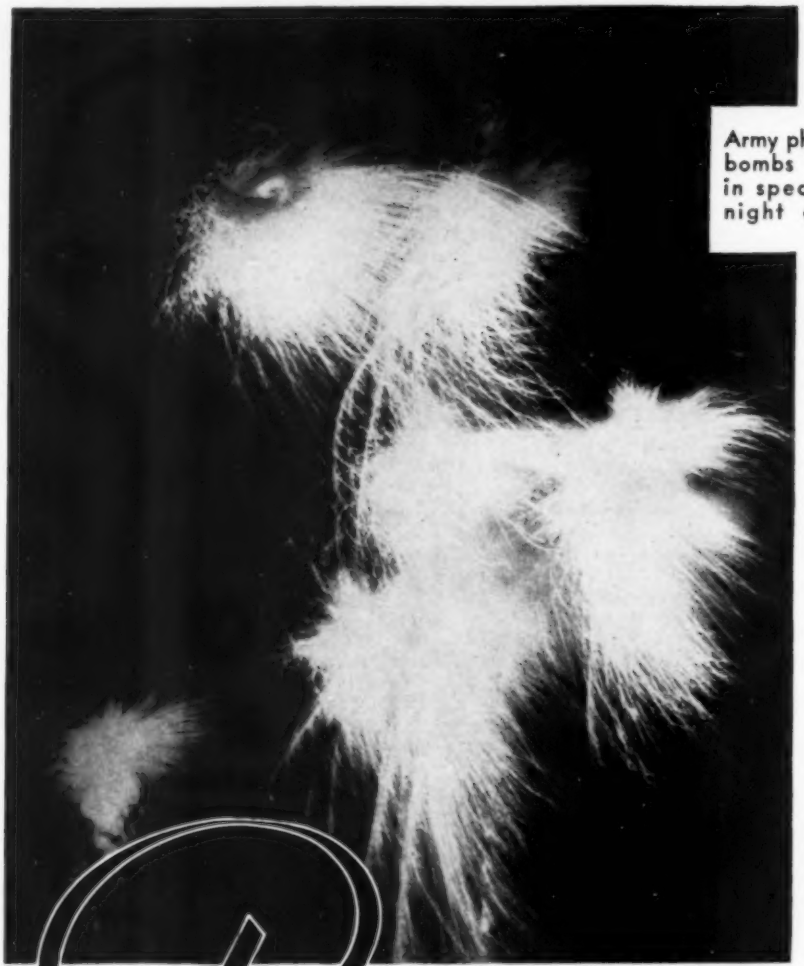
DYE IS INJECTED near the left end of the cell shown in the center of the photomicrograph below so that the colored protoplasm can be followed as it makes its way toward the other end of the cell




Brown Fruit Dye Injected here to make protoplasm visible
Protoplasm hits cell wall and small amount seeps through to next cell

THE DYED PROTOPLASM is shown here as it reaches the partition at the end and a small amount filters through to the next cell. The photomicrographs were made in polarized light





Army phosphorus bombs bursting in spectacular night display

Phosphorus . . .

EXPANDED PRODUCTION TO PAY REWARD IN PEACE

By ALDEN P. ARMAGNAC

HAVE you noticed, lately, how the striking surface of your pack of safety matches has shrunk? At the request of the War Production Board, manufacturers have trimmed the width of the dark reddish-brown strip, which contains the phosphorus that lights the match. The part that you and millions of others don't get is boosting America's vitally needed supply of phosphorus for warfare.

What good is phosphorus in a fight? First, it's the No. 1 smoke screen of the Chemical Warfare Service. WP—military shorthand for white phosphorus—burns to

an impalpably fine powder, which readily dissolves in the moisture of the air. The result is a dense white fog, so impenetrable to vision that it effectively conceals movements of troops or ships. Smoke from a single burst of WP lasts about 10 minutes, and may be maintained as long as desired by continued fire. It may be hurled at the enemy in hand and rifle grenades, in shells for light and medium caliber artillery, and in air bombs. Each projectile bears a single yellow band denoting "smoke." Popular belief that phosphorus vapors are highly poisonous has been found less than a half-truth; although toxic when concentrated, as in a laboratory, they become harmless on the battlefield by diffusion and interaction with moisture. Tests have shown that troops can advance through a WP cloud in safety.

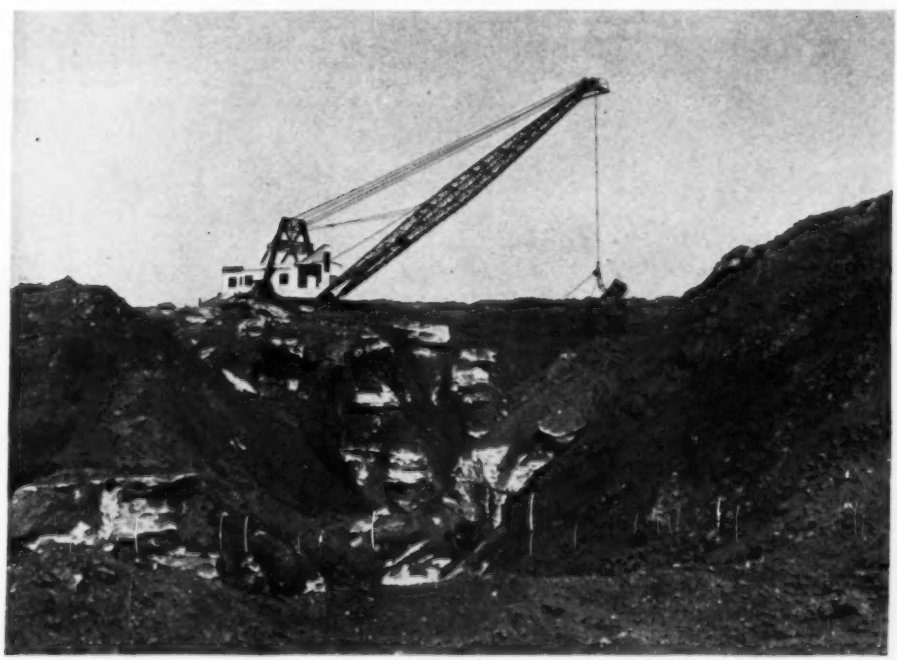
Not so mild is the casualty effect of a WP burst upon personnel in the immediate vicinity. Flaming particles of phosphorus, clinging to skin and clothing, inflict painful burns that are slow to heal. Because enemy troops well know this, their morale suffers out of proportion to the actual casualties produced by WP bombardment. Also, the burning fragments stampede animals.

As an incendiary agent in bombs and shells, phosphorus has a potent competitor in thermite-type bombs, which burn far more fiercely. Against well-constructed fireproof buildings, phosphorus bombs would be wasted. Flimsy, tinderbox structures like those of Japan might prove more vulnerable; to an imaginative Oriental, the striking picture on the opposite page could suggest a fire-breathing dragon over Tokyo.

Scatter-type phosphorus missiles have been designed by the British to set fire to enemy crops and lumber-producing forests. German patience, so often exhausted, must have plumped to a new low when R.A.F. raiders began sowing these incendiary "calling cards" over the countryside a couple of years ago. A single plane carries as many as a quarter of a million of them. Each three-inch-square card contains a pad impregnated with phosphorus, moistened to delay its taking fire, which it would otherwise do immediately. About ten minutes after it has been dropped, on the average, the moisture dries out and the phosphorus ignites spontaneously. The resulting flame, about eight inches long, suffices to touch off grain or forest undergrowth within its reach.

Safety matches represent by far the greatest total of civilian products which, in finished form, contain pure or "elemental"

Phosphorus-bearing ore, called matrix, is mined in quantity from open pits by big electrically operated drag-line excavators to get the raw material for phosphorus



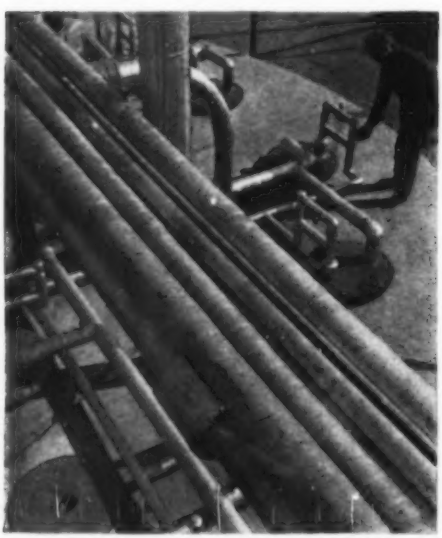
phosphorus. The match itself has no phosphorus in it, but simply carries a tip of highly combustible material. The striking surface is impregnated with red phosphorus, a safe variety—tin will melt before red phosphorus will ignite. When the match is struck, friction converts a trace of red phosphorus into the white form, which sets fire to the match tip. Ordinary kitchen matches do not use pure phosphorus at all, but are tipped instead with a compound called phosphorus trisulphide and an oxidizing agent, which are ignited by friction against any rough surface.

The two principal kinds of elemental phosphorus make a strange Jekyll-and-Hyde pair. White phosphorus—actually yellow, unless highly purified—has been banned for matchmaking because long-continued handling induces bone disease of the jaw. Yet its vapor is identical with that of harmless red phosphorus, and the second commonly is prepared from the first. A third form—black phosphorus—has been produced experimentally by heating white phosphorus under tremendous pressure. It won't burn at all.

Mass production of the element phosphorus from its ore, phosphate rock, has been made possible only by technical advances of recent years. A plant set down in the midst of Tennessee deposits by the Monsanto Chemical Company, a pioneer in the field, illustrates how the extracting process works.

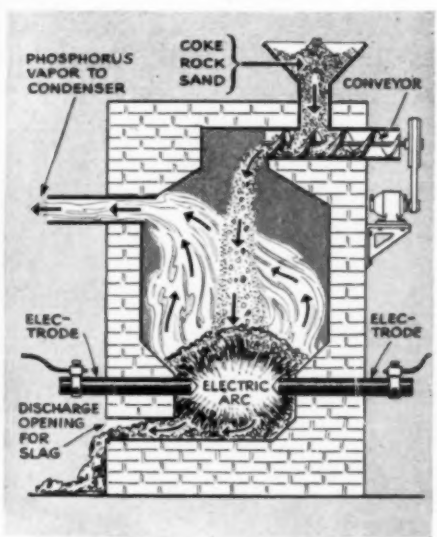
ORE IS SEPARATED from clay and rock by vigorous washing in the "big tub" in the background above. Each bite of the bucket will scoop up 15,000 pounds

Like a monster power shovel—except that wire cables replace a rigid boom—an electric machine called a drag-line excavator draws a huge bucket over the face of the exposed deposit. At one bite, the scoop picks up 15,000 pounds of the soft brown matrix,



PHOSPHORUS VAPOR, the main product of the furnaces, is condensed and stored under water in huge semi-underground tanks like this. Each tank will hold about 1,000,000 pounds of phosphorus

PRINCIPLE OF MANUFACTURE. How an electric furnace makes phosphorus from the treated ore is illustrated in the cross-section drawing. Air, which would react with the product, is excluded



CART-SHAPED MOTOR TRAILERS take ore to a sinter building (left above) where it is prepared for the electric furnaces in the building at right

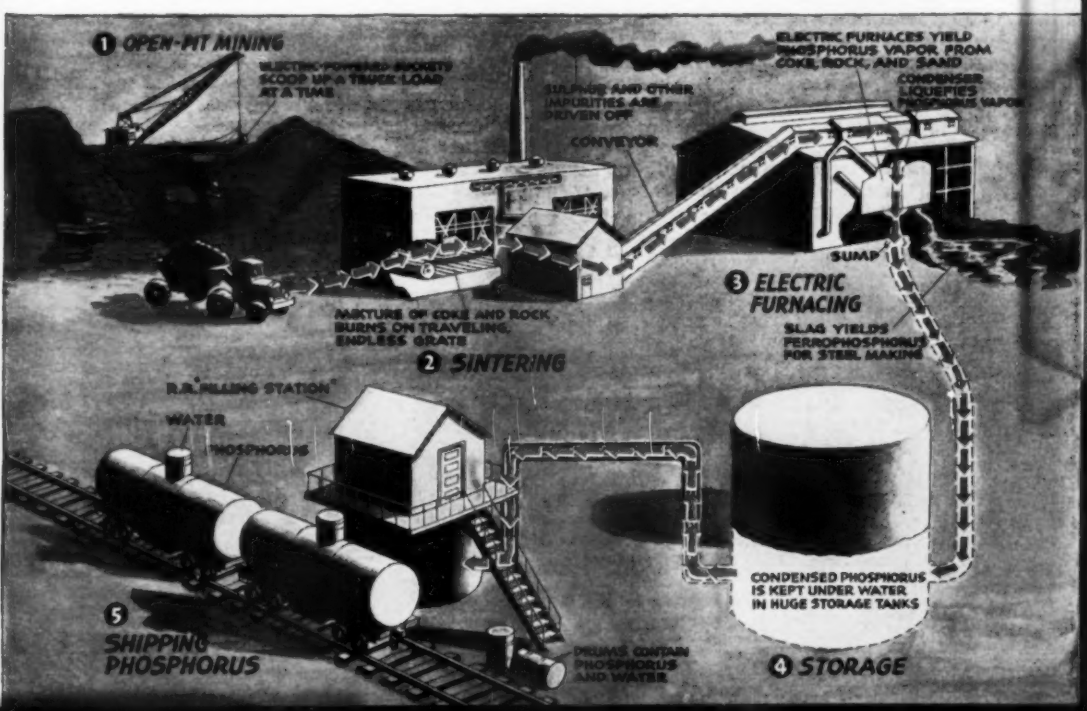
BY-PRODUCT of treatment in the electric furnaces, ferrophosphorus is tapped in slag, as shown above. It is used in making steel

as the ore is known, and dumps it in a waiting truck trailer.

Copious washing separates the clay and worthless rock from the matrix, which then goes to the sintering machine. This is nothing more than an endless, traveling grate of eight-foot width, through which fans maintain a down-draft of air. Coke intimately ground up with the matrix, is ignited at the receiving end. By the time the mixture reaches the discharging end, the coke has burned out, leaving the rock in the form of a "sinter," or coherent mass. This pretreatment serves several purposes. It drives off such impurities as sulphur and fluorine, whose fumes go up a stack. Also, it thoroughly dries the matrix.

Now the ore is ready for a bank of four big

PHOSPHORUS-MAKING CHARTED FROM ORE TO PRODUCT

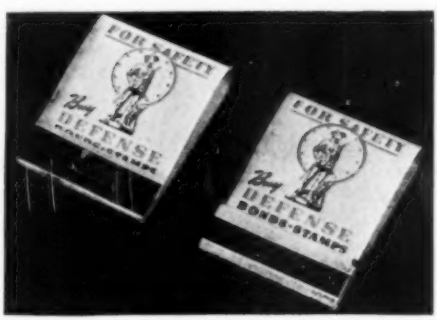

1 OPEN-PIT MINING
ELECTRIC-POWERED SHOVELS SCOOP UP A TRUCK LOAD AT A TIME
SULPHUR AND OTHER IMPURITIES ARE DRIVEN OFF
CONVEYOR
ELECTRIC FURNACES YIELD PHOSPHORUS VAPOR FROM COKE, ROCK, AND SAND
CONDENSER LIQUEFIES PHOSPHORUS VAPOR
SUMP
3 ELECTRIC FURNACING
SLAG YIELDS FERROPHOSPHORUS FOR STEEL MAKING
MIXTURE OF COKE AND ROCK BURNS ON TRAVELING, ENDLESS GRATE
2 SINTERING
R.R. FILLING STATION
WATER
PHOSPHORUS
CONDENSED PHOSPHORUS IS KEPT UNDER WATER IN HUGE STORAGE TANKS
5 SHIPPING PHOSPHORUS
DRUMS CONTAIN PHOSPHORUS AND WATER
4 STORAGE

Inside and outside of an incendiary "calling card" used by British flyers to destroy enemy crops and forests. One plane can drop 250,000 of the cards

electric furnaces, consuming more than 10,000 kilowatts apiece. More coke, sintered rock crushed to the same size, and sand meet the blazing arc produced by alternating current. Vapors of phosphorus and of carbon monoxide rise from the reaction. Both would promptly react with oxygen, but for elaborate precautions to exclude air from the furnace. Led off from it, the phosphorus vapor passes through a condenser that turns it into a liquid, and it is collected under water in underground sumps. Pumps then transfer it to concrete storage tanks, each with a capacity of 1,000,000 pounds of phosphorus, where once again it is kept from contact with air by a blanket of water. It reaches its destination in water-filled drums or in railroad tank cars of special design, with extra-high domes containing water.

As in all well-engineered chemical plants, other products of the electric-furnace reaction do not go to waste. The carbon monoxide gas serves as fuel for igniting the incoming material on the sintering machine. As for the slag, which has been made free-flowing by being quenched while molten in a high-velocity stream of water, and is drawn off into a "slag pond," it too is a useful co-product. Iron, present as an impurity, has combined with some of the phosphorus. The resulting alloy, ferrophosphorus, is sold to steelmakers. Phosphorus likewise plays an important role as an ingredient of phosphor bronze.

Aside from pure phosphorus and its alloys, one standard chemical dictionary lists more than 100 important chemical compounds containing phosphorus. Another cites no less than 463 uses for just one of them—phosphoric acid. A familiar ingredient of soft drinks, including "phosphates," of baking powder, of fireproofing agents, and of fertilizers, this chemical has been produced automatically by treating phosphate rock (crude calcium phosphate) in electric furnaces—with the difference from the Monsanto process that air is allowed to enter the furnace, converting the phosphorus to phosphoric acid as fast as it is formed. Now Monsanto has found that its pure phosphorus permits making phosphoric acid of greater strength and purity than any hitherto known. In the beneficial uses that result, the element phosphorus more than makes amends for its wartime uses in battle and destruction.



SAVING PHOSPHORUS FOR WAR. The wide striking surface of an old pack of safety matches (left) has given way to a narrow strip. Strip contains the phosphorus.

Un-Natural History

BY Gus Mager

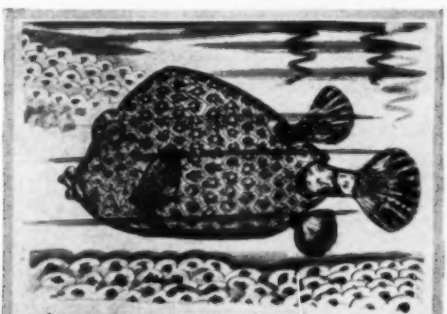
DOGS, WITHOUT KNOWING THE REASON WHY, USUALLY TURN AROUND SEVERAL TIMES BEFORE LYING DOWN! THIS IS SAID TO BE A TRAIT INHERITED FROM WILD MEMBERS OF THE DOG FAMILY WHO TURN ABOUT TO MAKE SURE THEY HAVE THEIR KEEN NOSES POINTED UP-WIND!

THE CURIOUS **DIPPER** OR **WATER OUZEL** OF NORTH AMERICA NESTS NEAR SWIFTLY RUNNING WATER OR EVEN BEHIND FALLS! ITS PLUMAGE IS SO DENSE AND OILY THAT IT CAN DIVE UNDER WATER AND NOT GET WET!

AN INSECT OF CHINA, THE **LANTERN FLY** WAS SO NAMED BECAUSE ITS LONG PROBOSCIS WAS SUPPOSED TO BE PHOSPHORESCENT! HOWEVER, THIS CLAIM HAS NEVER BEEN PROVED BY SCIENTISTS!

INCREDIBLE AS IT MAY SEEM, THE **HORSESHOE CRAB** IS NOT A CRAB! IT IS NOT EVEN A CRUSTACEAN! ACCORDING TO SCIENTISTS, THE HORSESHOE CRAB'S NEAREST RELATIVE IS THE SCORPION!

THE **GOBY,** A FROGLIKE FISH OF AFRICA, CLIMBS TREES TO DESTROY WOOD ANTS' NESTS AND TERMITES! SOME OF THE FISH CLIMB UP TREES WHILE OTHERS WAIT BELOW TO SEIZE THE DISLODGED VICTIMS!



ARMORED LIKE A TANK WITH A BONY SHELL, THE **TRUNK FISH** CAN MOVE ONLY ITS EYES, JAWS, FINS, AND TAIL! A NATIVE OF TROPICAL WATERS, HE IS WELL CAMOUFLAGED WITH GEOMETRICAL SPOTS WHICH RESEMBLE LIVING CORAL!

"Shooting the sun": A student navigator at Kelly Field learns to use a modern sextant, one of the tools with which he will guide a big bomber unerringly to its target across miles of trackless sky

Navigators in

Clear Heads and Mathematical Skill Are Needed for Guiding Big Bombers to Their Targets

By HERBERT ASBURY

HEADED out to sea for a final smash at a Japanese fleet which had already been badly battered during the first phase of the Battle of Midway Island, the pilot of a Flying Fortress received orders to turn aside and attack another powerful Jap force approaching the American base from a different direction. In a matter of minutes the bomber's navigator had to consult half a dozen complicated instruments, determine the wind direction and drift, calculate his speed, position and altitude, and plot an entirely new course.

"But all that didn't bother our navigator," said the pilot. "He just went to work and as usual did a very superior job. In no time at all he told me we would reach our targets at 34 minutes past the hour, and sure enough we hit it to the minute."

The skill, speed, and accuracy with which this navigator worked out his problems were duplicated in a hundred other bombing planes both at Midway and in the Coral Sea.

In a twin-engined AT-7 training ship fitted out like a bomber, the cadet gets 100 hours of individual practice

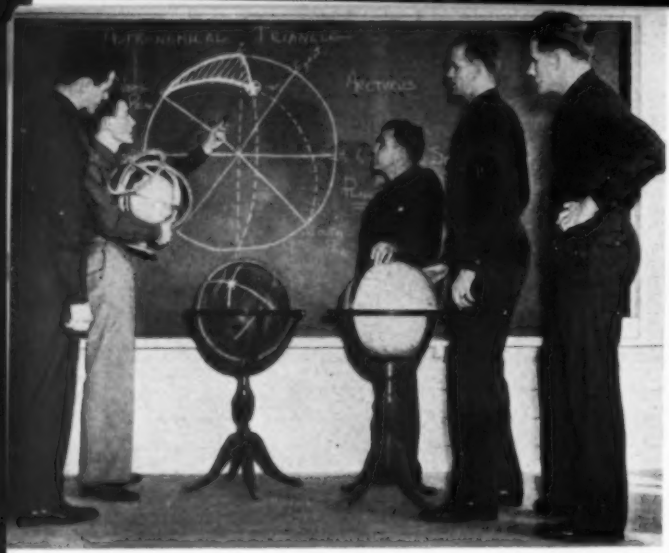
Working out a problem in aerial navigation. You don't have to be a math wizard, but must know trigonometry

the Making

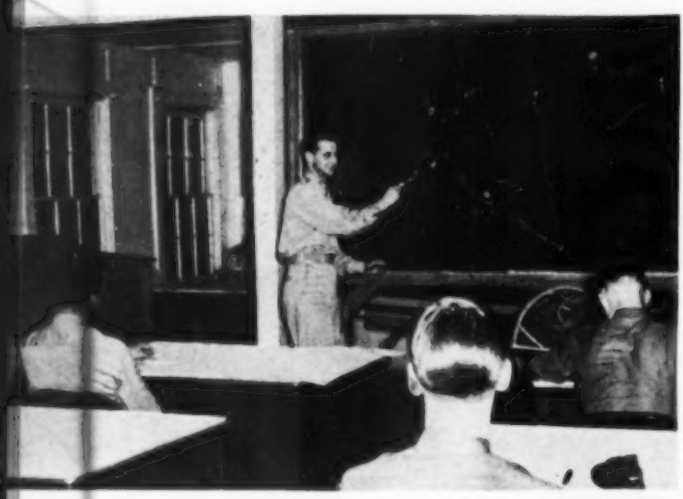
Tales of such precise navigation, appearing with increasing frequency in press dispatches, have awakened the American people to a realization that the young officer with the charts and navigational gadgets is one of the most important figures in military aviation.

He is the key man of the modern aerial combat team, the man behind the man at the controls. The pilot flies the ship, and the bombardier drops the bombs, but it is the navigator who gets them there. And it is the navigator who brings them home. To him belongs a heavy and vital responsibility —he must know at all times, or be able to calculate within a few minutes, the exact position of his plane. Upon his knowledge and the skill and quickness with which he uses it, depends the success or failure of a bombing mission. A poor navigator may take a bomber miles away from its objective and put both ship and crew in dire jeopardy.

Recognition of the navigator's vital importance, particularly in long-distance bombing operations, has been mounting since the outbreak of the war, and it will mount even more rapidly when the full story of the raid on Tokio is released. Every ship carried its own navigator, and every navigator plotted the course which would take his bomber over Tokio and the special target



During his 15 weeks of intensive training in navigation school, the cadet spends 460 hours at highly technical studies in the classroom



It's just like going back to school. With increasing bomber ranges, celestial navigation becomes more and more important. Students learn how to read maps and to use instruments

Time is a big factor in an aerial navigator's work. A bomber may fly as far in an hour as a ship steams in a day. Here a group of cadets check their watches by Naval Observatory time

assigned to it for destruction. If the navigators had permitted the ships to get off the course, the operation would have been a failure.

"I guess we did a pretty good job at that," said a young officer who piloted one of General Doolittle's ships. If we had made many mistakes we probably wouldn't have got there. But every one of our bombers reached Tokio at exactly the time it was supposed to be there, and we skimmed along over the Tokio rooftops just as we had planned to do. We certainly took the Japs by surprise, and believe me we did a lot of damage. I don't believe anybody missed his target. The Japs were so upset they didn't seem to know what to do. They sent up a few interceptors and turned loose a lot of antiaircraft guns, but they didn't bother us very much. We outran their fighter planes and plowed through the ack-ack with no trouble at all. One Jap interceptor who was skirmishing around to get on the tail of the plane I was in ran into a big burst of his own antiaircraft fire and went down in flames.

"It wasn't hard to plot the original course for the Tokio flight, because we knew where Tokio was and where we were going after we left Tokio, and we had

wonderful charts and maps. But all through the flight the navigators had to keep checking and correcting the course, and they had to be able to tell their pilots at any minute exactly where they were. There are several ways of finding that out, of course. One that I used a few times was to take a 45-degree sight on a star and then draw a circle on the chart. Then I'd do the same with another star, and where the circles met was where we were. Then of course I took a lot of double drifts. To do that you turn the plane 45 degrees off the course for a minute or two, then make a right angle turn and fly for the same length of time, and then turn the plane 45 degrees back to the original course. By making observations on each of the turns you can find out what the wind is doing and how it is affecting your speed and direction.

"The wind causes most of the trouble and problems encountered in aerial navigation. If there weren't any wind, navigation would be simple. But any wind will throw an airplane off course. With a one-mile wind the ship will drift off one mile, with a five-mile wind five miles, and so on. So the navigator must always keep an eye on the wind. You might almost say that if he knows the wind he knows everything. When I was in training I thought maybe we heard a little too much about the wind, but since I've been navigating these big bombers I realize I can't know too much about it."

"Are you sorry you didn't try for pilot or bombardier?"

"No. I'm glad I'm a navigator. I get a great kick out of navigation. It's really wonderful to sit up there in the clouds, maybe with antiaircraft shells exploding all around—and, by the way, that's very beautiful stuff when seen through a telescope—and realize that the big bomber is going just where I say, and that it's up to me to bring it back home. Sometimes the navigator gets a whack at the other stuff, too. When the bomber is busy over the target he usually acts as fire-control officer, and in some types of medium and heavy bomber he is also the bombardier. Most navigators can fly the plane, too, if necessary, at least well enough to get it out of danger."

Before the Midway and Coral Sea our navigators had already earned their spurs by their bravery and efficiency in Java and other islands of the Dutch East Indies during the Japanese push southward from Singapore.

"Our navigators were especially fine in Java," said an American airman with considerable experience in the southwestern Pacific. "It was all navigation there. From the air, because of the density of trees and vegetation, Java looks like a solid sea of green, with no outstanding mountains or other prominent landmarks. Every flight had to be organized as if it were over the ocean, and of course most of them were at least partly over water. Without first-class navigators our ships would have been helpless"

The whole setup of the Ferrying Com-

Ready to go aloft, the student at left, below, is studying the day's problem. His instruments and charts will go into a briefcase when, with some of his classmates, he boards a plane for a practice flight. Problems in day and night flying teach them to reduce flight to a mathematical equation—and solve it

Seated inside the training plane, these embryo navigators are alert and ready for the day's lesson. Telephone connection with the pilot enables them to receive orders

mand, which handles the delivery of bombers to our allies in England and North Africa, is dependent upon the navigator. All of these flights are made over the sea and at very high altitudes, and some of them take the bomber over unfriendly country. It is essential that the ship stay on its course, and that course must be set and maintained by a man who understands celestial navigation and dead reckoning. The pilot, copilot, and engineer on one of these ferrying flights can usually find time for a bit of a nap, but the navigator must be on the job every minute he is in the air. When he finally tells the pilot to "set her down, we're there," he must know what he is doing. There is seldom enough gasoline in the tanks to allow for mistakes.

Twenty-nine weeks of individual instruction, plus an indeterminate period of crew training, are required to transform a fledgling aviation cadet into a capable navigator. To enlist for this vitally important job a man must be between 18 and 27 years old. In general the impression seems to prevail among young men interested in aviation that only a mathematical wizard can hope to become an expert navigator. That is wholly untrue. Any one whose mathematical studies have included a little trigonometry can handle a navigator's work without difficulty. And in most cases a boy who hasn't even had trigonometry can get along provided he has a mathematical bent and takes instruction readily.

The Army Air Force maintains three preflight schools, at Turner Field in Georgia, at Kelly Field in Texas, and at Mather Field in California, for the preliminary training of cadets who pass the physical and qualifying tests. At these schools, where the cadet remains for nine weeks, he is given courses in identifying air and naval craft, mathematics, physics, meteorology, Morse code,

The navigator's instrument board, below, is simple in comparison with the dial-studded panel in the pilot's compartment, but it gives him the information he needs in calculating where the plane is, which way it is going, and how fast. The cadet learns to read his dials quickly and accurately, and to use special instruments like the drift meter seen at left

athletics, and military customs and regulations. He does a little drilling, but no flying, and is introduced for the first time to elementary navigation.

From the pre-flight school the cadet goes to navigation school for 15 weeks of intensive training. There he learns how to read the maps and charts which are to be an important part of his equipment, and how to use the tools of his new trade—the gyroscope drift meter, the sextant, the air-speed indicator, the thermometer, the altimeter, the turn indicator, the parallel rulers, the chronometer, and the magnetic compass, calibrated to give true direction. When he can handle these instruments, he receives advanced instruction in the four phases of navigation—pilotage, dead reckoning, radio, and celestial—and gets 100 hours of flying in a twin-engine trainer which is enough like a real bomber that later he experiences no difficulty in making the change-over. All this is individual instruction. After he is through with the school and has been assigned to a unit he receives crew training in a four-engine bomber to develop the teamwork which is so essential to successful operations.

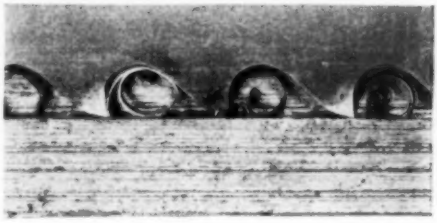
The last five weeks of the cadet's training course is spent at a gunnery school, where he is taught to fire the cannon and machine guns with which a bomber is armed. Then, unless he has fallen by the wayside, he is graduated and commissioned a second lieutenant in the Air Force Reserve. While in training, he is paid $75 a month, plus one dollar a day for subsistence, and also receives living quarters, medical service, uniforms, clothing, equipment, and a $10,000 life-insurance policy which he can continue at his own expense after he has become an officer. Upon being commissioned he gets an allowance of $150 for uniforms, and goes on the payroll at $245 a month, the total representing his pay and various special allowances.

At work in the flying classroom. The navigator in the foreground transfers drift data to his plotting table, while the man behind him takes a sun sight

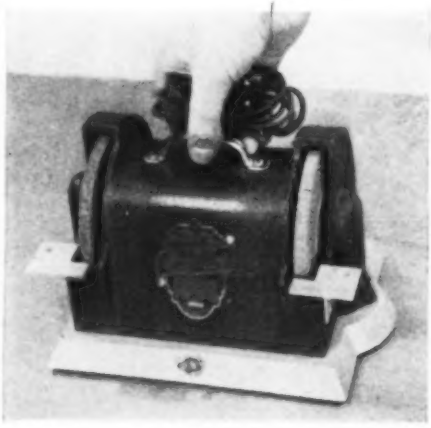
Working complex mathematical problems miles above the earth is tough enough, but the aerial navigator has the additional handicap of wearing an oxygen mask for long hours at high altitudes. The man below is adjusting his aperiodic compass. On the table before him are his sextant and parallel rulers. At right, using the sextant through the revolving turret

new Tools

HEAVY-DUTY METAL CUTTER. A "curled-chip" saw, recently developed, is said to make faster and smoother cuts and eliminate the jamming of metal chips. Unlike the conventional angular-tooth saw, which telescopes chips against the cutting face of metal, the new teeth get under the chip and curl it up like a clock spring before it is ejected. This action is said to keep the cutting surface clean and to reduce friction. No tooth on the "curled-chip" blade is required to cut the full width of the kerf and, therefore, heavier feeds are possible without excessive heating and break-down of cutting edges.

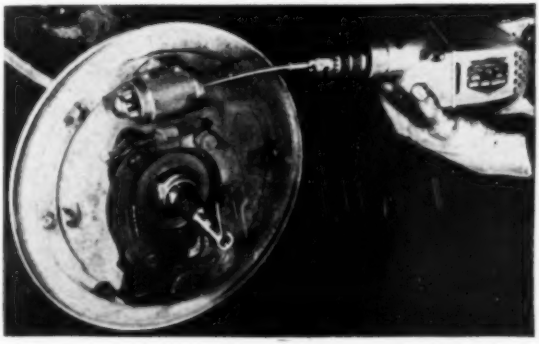


Above, at top, the heavy-duty metal cutter, with a close-up view of "curled chip" teeth and the big curved chip gullets that prevent jamming of metal

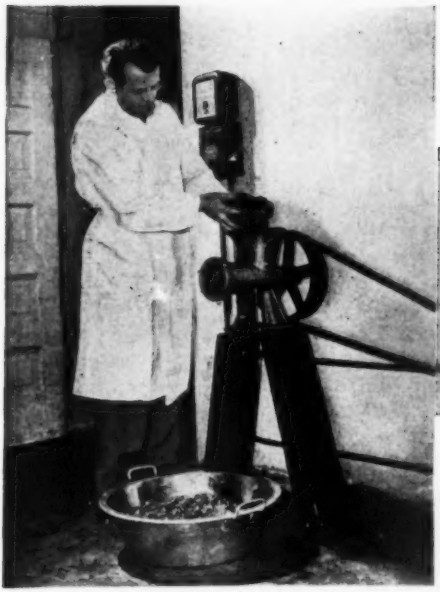


A NEW PORTABLE BENCH GRINDER now makes it possible to sharpen drills, hand tools, knives, and cutter bits wherever need may arise. Completely housed in a modern cast housing, the grinder is equipped with an electric motor that swings two 4⅜" by ⅜" grinding wheels. Rubber feet deaden motor noise and give the grinder a nonskid base that will not mar a polished surface. A rigid tool rest slides in or out to give the desired tool angle or compensate for wear on the wheels. The grinder operates on any 110-volt circuit. This is a versatile machine for the home or shop.

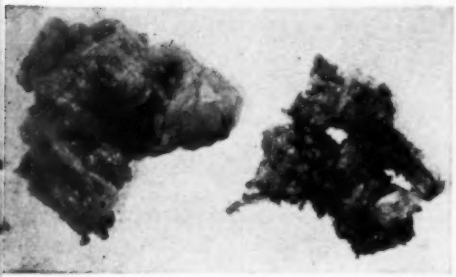
GRINDING CYLINDERS of hydraulic brakes becomes an easier job with a new hone that is driven by a flexible shaft connected to an electric drill. The grinding mechanism consists of three medium abrasive and interchangeable stones that are thrown against the cylinder walls by centrifugal force when the hone is revolved. Brake cylinders need not be removed from the car while honing. This new universal tool will grind all hydraulic brake cylinders from 15/16" to 1½" inside diameter.



DEHYDRATED MEATS



Trimmed and boned, meat to be processed is ground as above, then partially cooked and put between heated rollers which press out much of the water

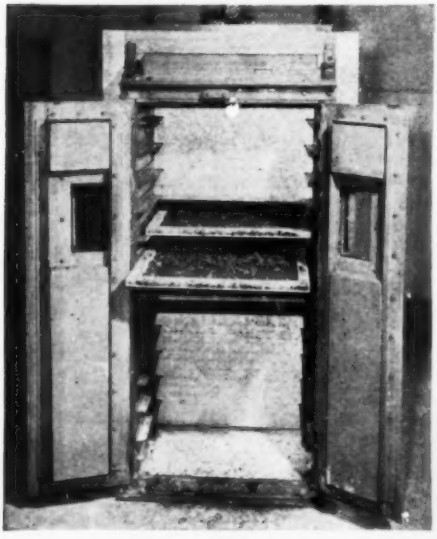


Fresh meat (left) and a piece after dehydration

AT THE Department of Agriculture research center in Beltsville, Md., scientists have recently developed an experimental dehydration process which removes more than 90 percent of the water from beef and pork. Since water is about 75 percent of the weight of these meats in their natural state, the dehydrated product promises needed conservation in wartime shipments.

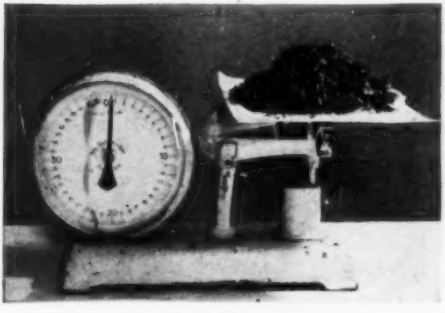
The meat is boned, trimmed, and ground, partially cooked at a temperature of 158 degrees, and then fed into a machine resembling a giant wash wringer where it is compressed between two heated rollers that remove a substantial amount of water. Next the meat is put on screened shelves in a cabinet drier through which hot air is circulated until dehydration is completed. The finished product may then be compressed to fit into a small part of the space required for untreated or canned meats.

So far at Beltsville, the processing has been done only on an experimental basis. Scientists there, however, predict an important place in American economy for the new space-saving product.

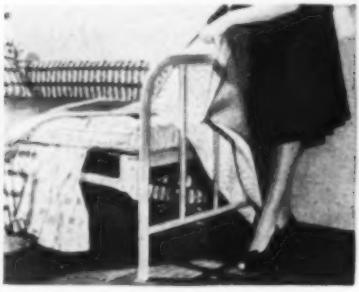


Final dehydration takes place in a cabinet drier, shown above, where the meat is put on screened racks. Hot air is circulated through the drier until all but 10 percent of the water is removed

As a result, a two-pound piece of raw meat weighs only .54 of a pound. The dehydration process is expected to help greatly in shipping conservation



Packed within itself, this furniture travels as a crate. The panels at the right, above, are tops of three tables



Opened, the case reveals the makings of a living room. A chest, a desk—and rug, table legs, and folded chairs in the drawers. At left, an Army-type bed upholstered as a couch

A Home in A Box

TO THE long list of things which come in packages can now be added a home. Interior decorators have designed and put on the market a "Home-in-a-Box" which includes almost all of the furnishings of a living room, packed into a container formed by several of the larger pieces. A single trunk, packed separately, contains the complete decor for a bedroom. These units, easy to ship and to assemble, are expected to be popular among Army wives and the families of war workers who have to move frequently.

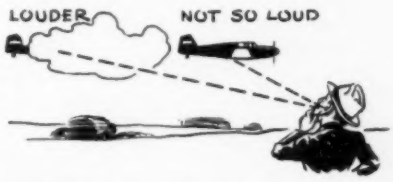
Her new home neatly furnished, the war wife relaxes. Perhaps the wall map suggests other places to move

Lugs hold the desk shelf and writing surface in place

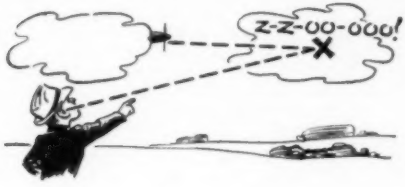
EARS HELP EYES SPOT PLANES

THE ear can help the eye in spotting planes. In a fog, or at night, it can even replace sight to tell a plane's approximate position, direction, and height. But the ear is not too dependable unless you understand some of the tricks that sound waves may play on it. Particularly interesting and useful facts for plane spotters, as pointed out by sound engineers of the British Royal Observer Corps, are illustrated below.

UNLESS the plane you are watching is very near, its sound will seem to come from some distance behind it because sound travels at a crawl compared with light. So when you have determined a hidden plane's direction, you know it's ahead of its sound



CONTRARY to what you might expect, sound travels faster through the moist air of a cloud and therefore is louder when it reaches your ears than if no clouds intervened. This should be remembered when estimating the distance of a plane on a cloudy night

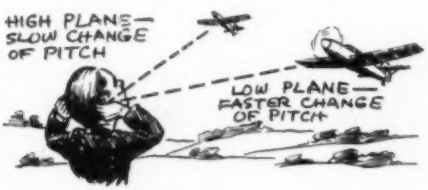


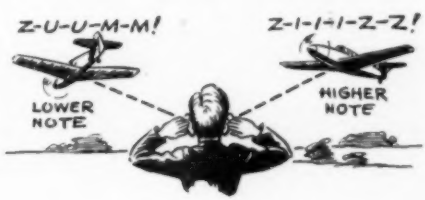
CLOUDS help you spot planes by making the sound of the engines louder, but they can throw you off in judging direction. The sound may be reflected from one cloud to another, making the plane seem to be in one place when it really is in another

HUMIDITY and heat speed up sound so that on warm days, particularly around evening, planes a long distance away may sound much closer than they are. Hazy weather and a low barometer also accelerate sound, which reaches you with less loss of volume

DRYNESS of the air plus cold weather retards the speed of sound appreciably, inducing such quandaries as that of the skier in the drawing at the left. If a wind is blowing from behind you, the sound will be still fainter. With a dry wind in wintertime, it often is difficult to hear the drone of a plane or even several of them no more than two miles away

REMEMBER your rule: Light vastly outpaces sound. For judging plane height, you should also know that sound travels so slow that its pitch, based on the frequency at which it reaches your ears, is changed by the motion of a plane toward or away from you. Putting these facts together gives spotters the following tips: The pitch changes very slowly if the plane is high; quite rapidly if it is low, as in the drawing at left, below. Moreover, the pitch rises as a plane approaches, falls as it departs, as indicated below at the right





Tempting Insects

Laboratory Workers Concoct Appetizing but Fatal Food for Destructive Pests of Farm and Garden

Army worms doing their "scorched earth" job on a collard leaf

By BRUCE ALLEN

THE theory that an insect poison should be so tasty and appetizing that a bug will smack his lips and go for it in preference to a fruit or vegetable, forms the basis of important tests now under way at the Department of Agriculture Research Center at Beltsville, Md. These palatable insecticides are still in the experimental stage, but the early work has been very successful, and they probably will appear on the market in the near future. Eventually you will be able to buy a spray or a powder flavored to tempt the appetite of the particular species of insect you wish to kill. Such preparations will provide another valuable weapon for use in the never-ending fight to control the bugs which annually ravage thousands of acres of farm land, gardens, and orchards.

Chemists and entomologists at the Center entered this new field of research when they discovered that codling moths ate heartily, but without injury, of apples which had been copiously sprayed with a common insecticide. Closer investigation showed that the moth, with a lot more sense than any one had ever given him credit for, was simply chewing his way through the poison and carefully spitting out the toxic agent. Then he would go to work on the apple as if it had never been touched.

This remarkable behavior could only be explained by supposing that the codling moth just didn't like the taste of the insecticide. To make certain that this was the case, the chemists reduced apple parings in a solvent, sprayed an apple with the solution, and invited a colony of moths to dinner. They ate freely of the poison with much apparent relish, but expired before they could get to the apple. The same procedure was successfully followed with the Japanese beetle, which is very fond of sassafras leaves. This little pest got a good taste of sassafras, but absorbed a lethal dose of the poison in time to prevent damage to the sprayed fruit. Other similar solutions are being made at the Center, based on the food preferences of various insects.

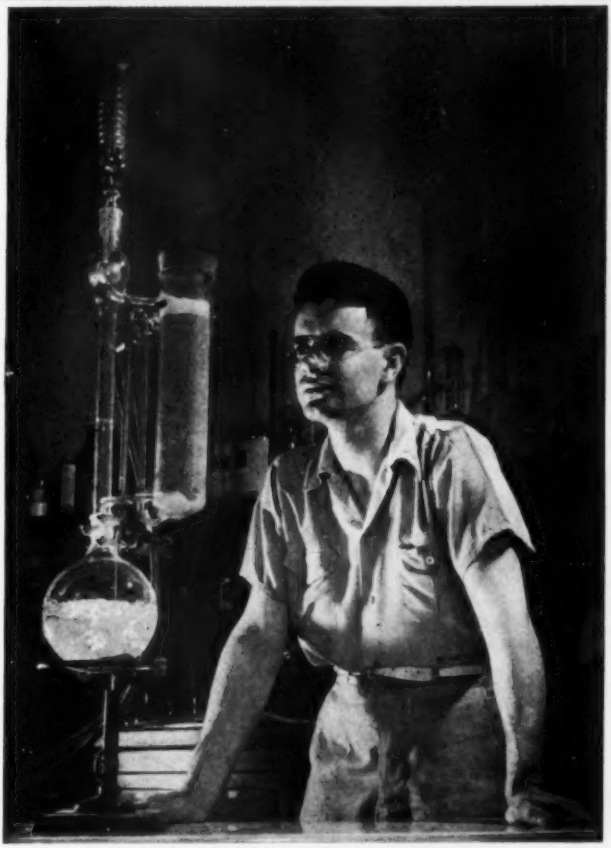
In another approach to the problem of insect control, L. D. Goodhue, a Research Center chemist, has developed a new spray called Aeroso!, which is composed of a low-boiling solvent, pyrethrin extract, and sesame oil. One drop of pyrethrin in this preparation, released in the form of a spray, is enough to kill all the flies and mosquitoes in a large room. The spray is as fine as smoke or fog, and will penetrate into places which the ordinary solution of this sort can-

With Poison

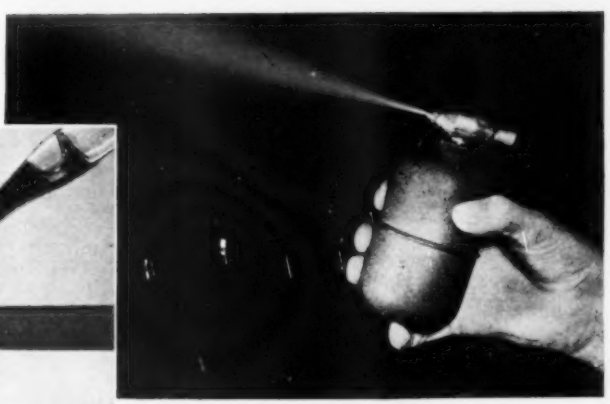
not reach. The insects simply cannot escape its potent action.

Recently Aerosol was tested in a clipper plane which had been purposely filled with flies in screened boxes all over the cabin and the luggage compartment. When the plane was in the air, Aerosol was sprayed. When the plane landed, every fly was dead. Other tests are being made by commercial air lines, which are using Aerosol to fumigate airplanes when they take off from tropical regions. The preparation is also being extensively used by the Navy to fumigate inclosed areas which might harbor malaria-carrying mosquitoes.

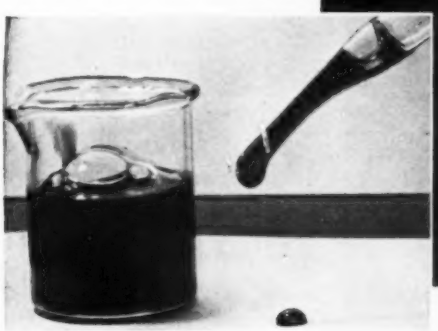
Chemists searching for new insecticides are limited in the number of basic poisons they can use because most of the inorganic compounds, such as arsenic

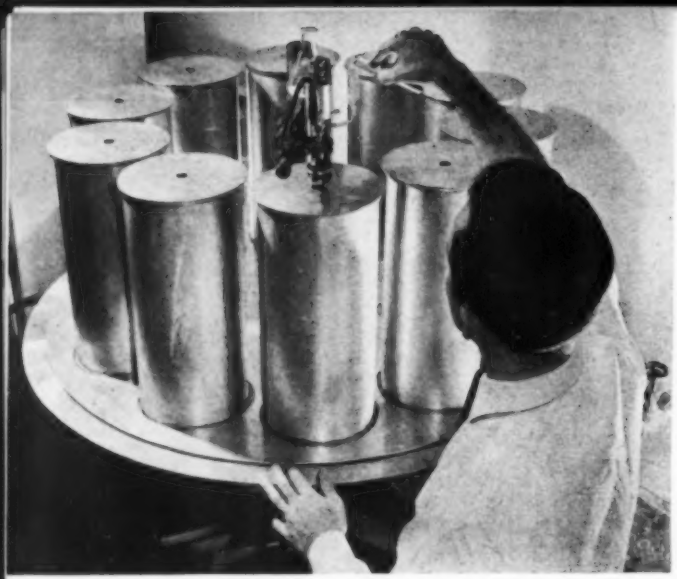


Extracting pyrethrin from a species of chrysanthemum for use as an insect poison. The apparatus shown in use is a modified Soxhlet extractor at the Beltsville laboratory



One drop of pyrethrin, below, in a new liquid spray called Aerosol, will kill all the flies and mosquitoes in a big room. Aerosol is sprayed from the handy container at the right





Killing power of contact insecticides is tested at the Department of Agriculture Research Center with the "Campbell turntable." Cylinders containing test insects are put under the insecticide spray

In a screen-covered dish, flies are placed under a cover slide in the base of the turntable. Then the cylinder is set over the dish, insecticide is sprayed in, and the slide is removed to expose flies

Glass cylinder at far left shows spray acting on insects. After 30 seconds, the dish is removed from the turntable and the flies are watched to see how they are affected. Use of the turntable allows several insecticides to be tested at once by changing liquids in the spray reservoir

and lead, are harmful to animal life. Even small quantities of arsenic sprayed on fruit will accumulate in the human body until enough has been absorbed to become poisonous. For this and similar reasons chemists prefer to use organic substances. Nicotine, which is obtained from tobacco, is one of the best-known insecticides. It is a contact poison effective against soft-bodied insects, such as aphids. But it is soluble in water, and often washes off plants during a rainstorm. Chemists are now working on methods to fix the substance so it will cling to a plant regardless of the weather.

Another frequently used poison is pyrethrin, which is extracted from a species of chrysanthemum. It is an important constituent of most fly and mosquito sprays, and of powders used to fight cabbage worms. Chemists are trying to find a substitute for this substance, as most of the pyrethrin used in this country has been imported from Japan and Kenya Colony. The bark of the prickly ash tree, a native of North Carolina, may be the answer to this problem. When treated with a solvent, this bark has shown itself to be similar in action to pyrethrin.

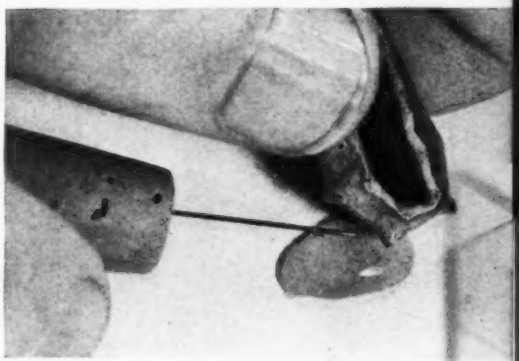
An enormous number of substances are examined at the Research Center for insecticidal properties in the course of a year, but only about 12 out of every thousand pass the preliminary entomological tests.

Army worms, at left, are among the "patients" of the insect clinic where tests are made to determine the effectiveness of various insecticides. Above, poison is being injected into one of the worms by means of a glass needle

Those that do pass are subjected to practical tests in the physiological laboratory, where are stored thousands of codling moths, army worms, silkworms, houseflies, mosquitoes, and other insect pests which have been reared under controlled conditions. Some of these can be killed by contact with the toxic agent of an insecticide, while others are not affected unless they eat the poison. To test the eaters, the insects are given green leaves treated with the substance under examination. The quicker they die, the better the poison.

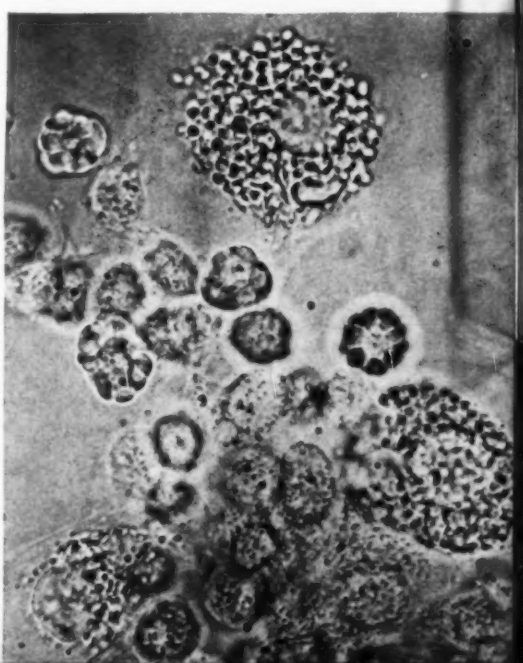
An instrument which consists of 10 large metal cylinders mounted on a turntable is frequently used for testing contact insecticides. Measured quantities of the preparation are poured into a small glass vial above one of the cylinders, and is then sprayed into the cylinder by a compressed-air blower. A slide is removed below the cylinder, thus exposing the flies to the insecticide. Ten tests can be made one after another by turning the table so that each cylinder comes under the spray. After thirty seconds of exposure, the screened cages containing the flies are removed and a count is made of the living and the dead.

The anatomy and physiology of the bugs are also studied in the Center's Insect Clinic, to obtain information on the functioning of the heart, blood, digestive tract, and other organs. One of the instruments used in this work is a cardiograph, invented by Dr. J. Franklin Yeager, which is sensitive enough to record the heartbeats of a cockroach. A bug is first anesthetized and dissected so that the heart is exposed, and is then placed on a small block. Over the heart is placed a hair to which is attached a tiny fragment of lens paper. As the cockroach's heart beats the hair moves, and a delicate glass thread travels across a light beam and records the movement on a photographic film. By comparing the records of normal and poisoned cockroaches, it is possible to learn the effect of a known poison on the insect's heart tissues and so find the combination that will kill the pests most efficiently.



After the worm has died, its blood is drawn and a drop is taken for study. Smeared on a slide, it is examined under the microscope to determine the effect of the poison on the cells

Below is a photomicrograph of a smear of fresh blood. Note how some of the cells have burst as a result of the action of the poison. This is the common tendency of arsenical compounds

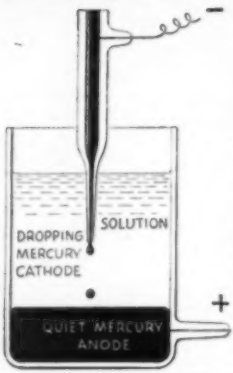


Electricity Analyzes Chemicals

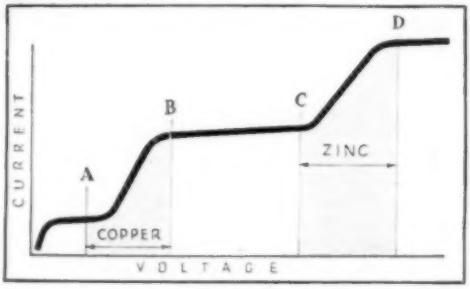
One unsuspected part of lead in 10,000 of zinc alloy, spotted by the Elecdropode, was breaking expansion shields, as right

TINY drops of mercury falling into a little beaker provide the working mechanism for a recently developed testing instrument with which chemical analyses that usually would require hours may be accomplished in a few minutes.

The operation of the Fisher Elecdropode, as the device is called, is based upon the fact that when a gradually increased electric voltage is applied between electrodes to solutions of different chemicals, each chemical makes its presence known by an increase in current flowing between the electrodes at some definite voltage. The amount of increase has a direct relationship to the concentration of the chemical. By comparing the electrical reaction of solutions tested, with solutions of known chemical composition, both the kind and quantity of the substances in the solution can be determined. The function of the dropping mercury is to provide a constantly clean electrode, free from plating.



Top, testing a chemical solution. Circle of arrow incloses beaker holding the chemical. In the sketch at right, above, the electrical hookup is shown, with a mercury drop forming. It will drop off before becoming plated



Right, dissolved chemicals pass more current at given voltages. Thus slowly increasing the voltage reveals presence of copper at A voltage, while rise in current flow between A and B shows copper concentration. Similar phenomena occur at C and D, revealing zinc

STAINED GLASS MAKING

American Artists Preserve a Medieval Art and Promise to Retain World Leadership

By AL LANEY

Working in transparent glass and opaque, soft lead, the modern maker of stained glass emulates the artist of old

WHEN, back in the year 1200 or thereabouts, they were building Chartres Cathedral, in which Gothic architecture and its decorative handmaiden, stained glass, reached their sublime peak, the glass-makers assembled on the spot to work in close co-operation with the architects. The story also is told—and there are men and women living in Chartres today for whom it is a fact—that these men worked under the direct command of Mary Queen of Heaven.

They set up their workshops in the little streets near where the other servants of Our Lady of Chartres were causing her greatest shrine to rise. Some of those little streets are unchanged to this day and unchanged too is the art of making stained glass.

Go into any one of the hundreds of studios and workshops scattered throughout America and you will find master craftsmen making contemporary glass in just the same way. Implements and tools have improved, materials have become more plentiful, and methods are more scientific, but the art remains the same.

The lines of the craft extend backward into the obscurity of the ninth century. In its golden age, the Middle Ages, it thrived as an art, but in the Renaissance it suffered neglect with the shifting of emphasis from architecture to painting. To save himself, the glassmaker worked out a compromise which, the best authorities agree, was a false step from which the industry has not yet entirely recovered. He abandoned the esthetics of his own craft and adopted those of painting. Along with the Gothic revival of the late eighteenth and early nineteenth centuries there was also a revival of stained glass, but the art had now been reduced to formula with windows manufactured on order in factories all over Europe. Out of this depression the art of our day began to emerge, and America is now carrying the torch.

The best glassmakers are agreed that at the beginning of the war Europe led America in the making of stained glass. America, they admit, still was looking back to the thirteenth century, slavishly imitating its achievements.

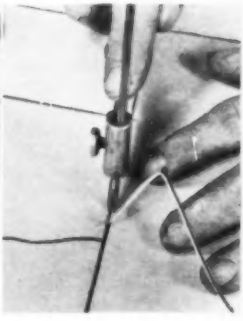
European glassmakers, on the other hand, had geared their craft to the times and were beginning to produce a contemporary art. More and more public buildings were installing decorative glass depicting contemporary scenes. In America, the demand for

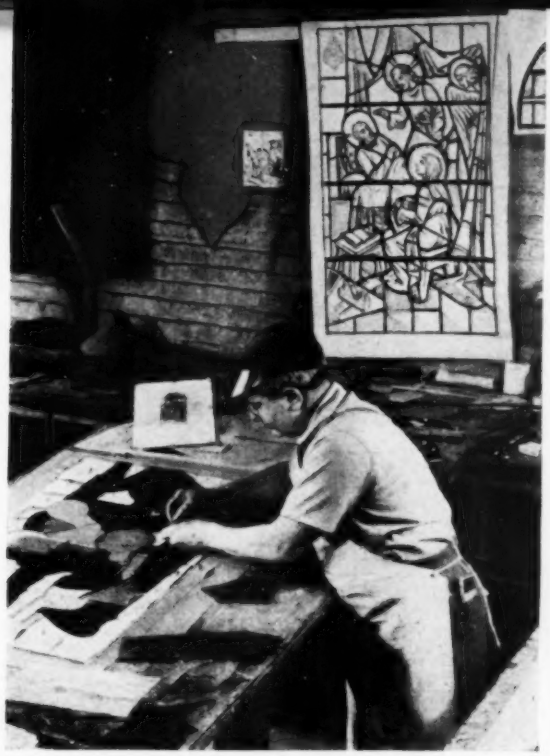
SKETCHING THE DESIGN. After consultation with client and architect on subject matter and dimensions, the craftsman sketches his conception of the windows in miniature and in full color

FULL-SIZED CARTOONS of the approved sketches are the next step. These are done in black and white with charcoal. They show the entire design and account for all pieces of glass to be used

TWO SETS OF TRACINGS are made of the lead lines drawn on the charcoal cartoons—one to be used as a glazing guide and the other to be cut into patterns for the individual pieces of glass

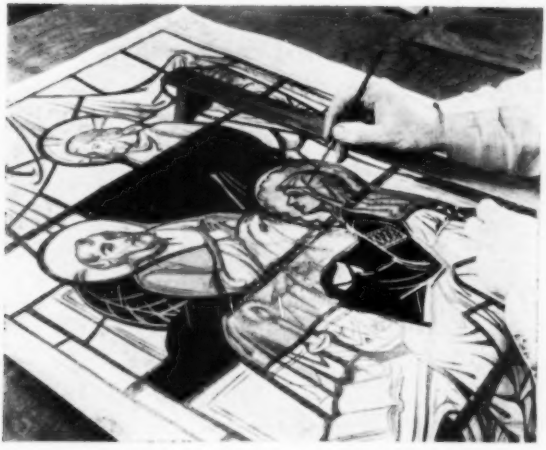
PATTERNS ARE CUT APART with special shears. These are double cutting and are used to take off the edge of each pattern enough paper to account for the width of the lead which will separate the individual pieces of glass and hold them together in the completed windows. If this space were not allowed, the windows would swell or increase in size, or otherwise fail to fit in with the plans worked out with the architect. A double knife is also employed to trim off excess paper. The two photos at right show the shears and knife in use





COLORED GLASS is selected for the individual pieces and cut out with a steel wheel or diamond cutter. The corresponding paper patterns are used as a guide during this process, and the pieces of colored glass are put in position on the tracing that was left intact. This assembling of parts is like fitting in a jigsaw puzzle

MAIN OUTLINES of form and design are traced on each piece of glass from the original cartoons. The artist fits one piece at a time over a drawing and completes it before going to the next. He uses fusible pigments



stained glass was overwhelmingly from churches, old and new, and many of these windows still came from Europe.

Maurice Lavanoux, secretary of the Liturgical Arts Society, which is striving valiantly to keep pure the stream of religious art, says categorically that up to September, 1939, the glass made along contemporary lines in Europe was better than that in America. Most of the influential men in the industry, the heads of the large commercial workshops and the individual artists working in their own studios, agree. But they hold with Lavanoux, too, that no better glass can be made anywhere than in the studios of America and that the closing down elsewhere will result in definite leadership for this country.

The American industry, which is far more extensive than the average person realizes, is roughly divided into three groups. There are first the large number of individual men and a few women who produce windows in their own studios, doing all the work themselves or with a few assistants. At the other end of the scale are the purely commercial workshops, little more than factories for the manufacture of windows, any size, any subject, colors to the customer's taste.

On the middle ground are the great majority of the workshops and studios. The Stained Glass Association of America, an organization embracing the entire country, includes most of them.

These shops are, of course, businesses—and in some cases big business—but, generally speaking, each organization of craftsmen is headed by a businessman-artist who is conscious of the fact that his business grew out of art.

That close co-operation between the medieval glassmaker and the architect which made the window a part of the whole from inception, is not always found in our day. Too often a stained-glass window is an afterthought and must be adapted to surroundings not originally intended for it.

Stained glass is generally understood to refer only to glass windows colored by such methods as the infusion of metallic oxides into the glass, the burning of pigment into the sur-

WAXING DOWN THE GLASS. The pieces are assembled again, but this time on a plate-glass easel, and are held in position with beeswax worked into the vacant spaces left between them

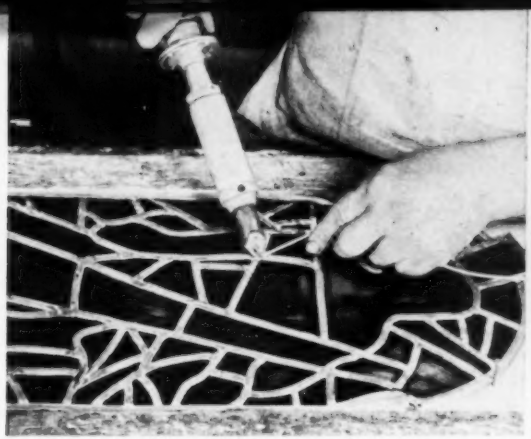
SHADING WITH PIGMENT is done with the easel held against a light. Here color relations are first studied carefully by the artist, and then the tones are deepened where necessary so that they blend perfectly

THIS CLOSE-UP of one of the figures at this stage shows that the glass, traced and shaded, is heavy in design. The paint is composed of metallic oxides, and will be fused permanently with the glass under the heating of the kiln

FIRING OF THE GLASS comes next with the pieces assembled on a special asbestos tray and put into the kiln as shown above. The fusing point for the glass and pigment is just short of the melting point of the glass, and heating must be watched closely

FINAL ASSEMBLING of the window is done with flexible H-shaped strips of lead. The pieces of glass are first laid out on the pattern and held in place temporarily with glazing nails

GLAZING is the name for the process of fitting the pieces together with the strips of lead. These flexible strips are bent to the required shape and cut to length with a sharp glazing knife. The legs of the H-shaped strips are placed over the two sides of adjoining pieces of glass which are separated by the horizontal bar. The two photos below illustrate these steps in glazing: at the left, how a strip of lead is cut to length with the oddly shaped knife; at right, how it is fitted around a piece of glass



SOLDERING OF JOINTS is necessary to hold the assembled glass together in the completed window. All ends of the strips are secured with a solder having a slightly lower melting point than the lead

CEMENT is next scrubbed with a brush into all crevices between the lead joints and the glass until the entire assembly is made waterproof. The glass is then subjected to thorough cleaning

face of white glass, or the joining of white with colored pieces of glass. A stained glass window is a translucent mosaic held together by lead.

In the accompanying illustrations, made in the Rambusch Decorating Company's studios in New York City, a typical contemporary workshop, you can follow the creation from conception by the artist to the completed work. The glassmaker may manipulate his materials—hard, brittle, transparent glass and heavy, opaque, soft lead—in a variety of ways, painting it lightly or heavily or not at all. But it differs vitally from painting on opaque surfaces.

If a congregation decided today that it would install one or more windows in the new church it is building or the old one that it is remodelling, what would it do? Assuming that there is already some understanding of the real nature of stained glass, the committee in charge would consult with the architect, who would in turn call in the glassmaker.

The glassmaker would first want the exact dimensions of the space to be filled and the subject to be treated. He would then ask the amount of money to be spent. If the right man is engaged, he can be trusted not to take advantage of this latter information.

Having informed himself of these essentials and consulted again with the architect, the artist would then make a sketch showing the window in miniature and in approximately its ultimate colors. From the moment the sketch is approved, the matter is entirely in the hands of the glassmaker. The church must now leave him to his work.

Turn to the illustrations and you will see what happens between approval of the sketch and the completed window. It will happen in just about the same way in any of the many studio workshops located in various parts of the country.

LARGE WINDOWS ARE MADE IN SECTIONS. These are in turn assembled with T-shaped saddle bars. Other supporting bars are used at intervals to insure permanent installation

AUTOS

How to Fix a Flat

IF YOU HAVE NO SPARE, YOU'D BETTER BE READY

By SCHUYLER VAN DUYNE

LEGIONS of motorists are driving their cars without spare tires and probably very few of them ever repaired a tire on the road. Few have even so much as a tire iron in their cars, an awful lot of jacks don't work, and, lacking a tire pump, a flat tire is an utterly hopeless catastrophe anyway.

What should be done? First, spareless cars should carry the tools, all in good working order, listed in the box on the facing page. They are basic stuff, and the most expert tire repairman could scarcely improvise substitutes.

While it need not be a back-breaking task, fixing a tire is no job for a sissy—particularly the pumping-up part. The average man

A tube repair kit with patches and cement is absolutely essential and should always be in your car

STEP-BY-STEP REPAIRS: Left, with car well off the road, pry off the hub cap with a screwdriver and loosen all wheel lugs with your lug wrench. Do these jobs before jacking up the car so that the force applied to the lugs won't upset balance

Right, with car jacked up and wheel removed, lay wheel flat on the ground and put one foot on tire wall. Press a tire iron against juncture of the rim and the tire bead to slide a portion of the bead into the rim's drop center. Use mallet cautiously to prevent damage

Below, once started, the rest of both beads can be forced by foot pressure into the drop center. Then, using an iron as a lever and holding opposite diameter of bead in drop center with one foot, raise part of bead

With one bead entirely off the rim (below), it is time to remove inner tube, separating bead and rim as much as possible and pulling straight down on tube as wheel is rolled. Then remove rim as below at the right

To repair a tube puncture, roughen edges with the grating on top or bottom of the repair kit and if possible wipe around the hole with gasoline. For a big hole, it may be necessary to apply a patch inside as well as out. After cutting patch to size, bevel the edges as at right above to prevent pinching

Left, cement has been applied to edges and allowed a moment to get tacky, and patch has been applied. It must now be rolled with edge of can to force out air bubbles

Right, if tire casing was seriously cut, insert light, reinforced adhesive patch on the inside of casing. This often is only temporary, to get you home. Have casing injuries vulcanized promptly

can handle it well enough. So can many women. In the accompanying pictures, photographed on the road with a tire expert showing you important steps, you can get a clear idea of the way to go about it under the conditions you will meet when you have to do it for yourself.

A good tip to start with is to loosen the wheel lugs slightly before you jack up your car. It is both safer and easier that way. Incidentally, some wheel lugs are loosened by turning in the direction the particular wheel turns when the car is backing up, which means that they have right-hand

EQUIPMENT NEEDED TO REPAIR MOST FLATS ON THE ROAD

TIRE PUMP. A tool-compartment necessity. Minus it, repaired tire is useless

JACK. They come with most cars, but often get broken or lost. Check up on yours

TIRE IRONS. Two are needed. If longer than 12", they too easily damage casings

SCREW DRIVER. This quickly loosens the hub cap and pries it from the wheel

RUBBER MALLET. If you can't buy one, make one of wood faced with old rubber

WHEEL CHOCKS. Placed before and behind a wheel, they keep a car on its jack

TUBE REPAIR KIT. Get one from your car dealer or garage; an absolute "must"

BLOWOUT PATCH. Should be light, with adhesive surface and cord reinforcement

SCISSORS. Necessary for cutting out the tube patches and beveling their edges

LUG WRENCH. The wheel, fortunately, won't come off without it. Another "must"

After repairs, tube goes back in tire. Stand tire up and start working in tube at highest point, beginning at the valve stem and working on around

Good remounting technique is shown above. Most of one bead is placed in drop center, the rest of it has to be knocked back with rubber-covered mallet

With foot and hammer, replace second bead as shown. A little air pumped into tube will discourage valve stem from slipping out of the rim hole

Right, after adding more air to seat tube and beads, wheel is replaced. Still jacked up, tire is pumped to 12 pounds for slow trip to air hose

threads on the right side of the car, left-hand ones on the left.

You'll be hard put to it to get a tire off its drop-center rim without a pair of tire irons and a mallet with a rubber head, or one of wood with rubber padding. Most of your hammering will be on the rubber surface of the tire beads, which a hard-headed hammer would injure.

Patches are simple to apply—if you have the patches. Handy repair kits containing the needed materials are obtainable at almost any garage. But they won't do much good unless you also have a pair of scissors to cut the patches out with. Twelve-inch tire irons (two) are another necessity, but they too can do great harm to both the tubes and casings if improperly handled.

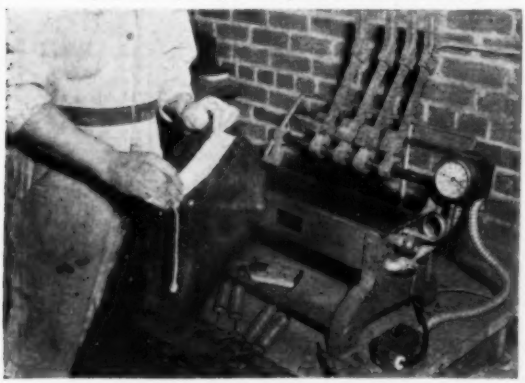
Most casings carry a small mark showing the right position for the valve stem of the tube. If you cannot find it, at least replace tubes just as they originally were. Never inflate a flat tire on a wheel mounted on a car unless the wheel is supported by a jack, or the tube will almost surely be pinched. Twelve-pound pressure is about all you'll feel like hand-pumping; it's a bare minimum for a short, slow ride to an air hose.

Even a Badly Injured Inner Tube Can Be Fully Repaired

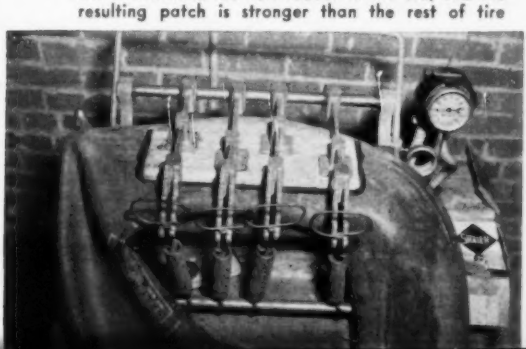
DON'T throw away an inner tube because it has a terrific tear or cut. The rubber shortage makes its repair imperative. The method used successfully by the U. S. Army and many repair shops, calling for a hot-plate press and more tools and supplies than the average motorist would possess, nevertheless mends even a 20-inch cut like the one illustrated below. When the shop repair is complete, the tube is declared not only to retain its original shape and balance, but to be strongest at the point of repair.

This apparently worthless tube is easily repaired in a shop. Rounded holes are cut at ends of rip, the edges are machine-buffed, cleaned with solvent, and gum cement is applied. Reinforcement is applied to inner side (center), and gap filled with rubber gum. Then it is rolled with a "hand-stitch" roller

Holland paper is next placed over the repair and the tube is ready for hot-plate treatment. If the injury is very long, it may have to be treated . . .



. . . section by section. A 20-minute hot-plate treatment vulcanizes the new rubber to the old, and the resulting patch is stronger than the rest of tire

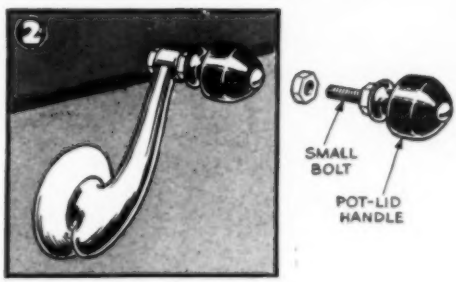


Below, the fully repaired inner tube that appeared in the first picture to be ready for the scrap pile. Curing has permanently sealed the rip. Notice the cut-out circles at each end to prevent further tearing. With patch inside, the tube surface is smooth

PRACTICAL HINTS

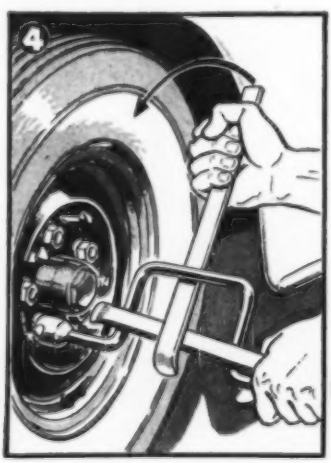
1 LEG PADS FOR POOCHES that like to ride with their forepaws on the window ledge of the car door will make a dog's life pleasanter and also protect the car finish. Slit a length of 1" mailing tube and place it over the glass as shown. Raise the window slightly above the sill so the dog's toe nails will not contact the paint.—J.R.

2 NEW WINDOW-CRANK KNOBS to replace those worn or broken off can be improvised from five-and-dime store pot-lid knobs. Remove the new bolt and replace it with a longer one on which two nuts are screwed. Insert the bolt with the knob in the hole that formerly held the pin, and tighten the nuts against the crank.—J.C.

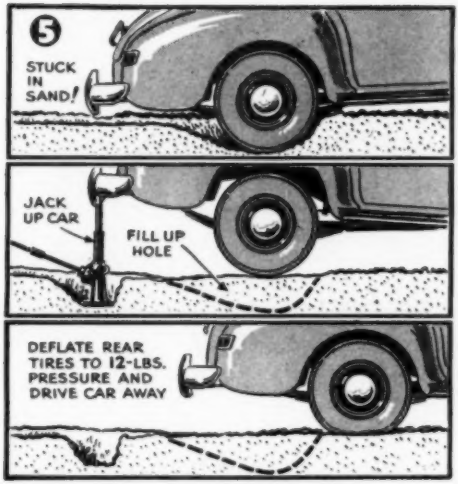


3 TO PROTECT YOU against getting bitten by the jaws of your alligator-type engine hood, an adjustable safety prop can be easily made from light lumber. Two pieces of 1" by 2" by 26" wood, one of them slotted part of its length, the other having two wing nuts and bolts with washers, are all the material needed. It is easily adjusted and fits all makes of cars.—L.M.

4 STUCK WHEEL LUGS which have been tightened too much or have rusted in place can be given an extra boost to loosen them with a pair of tire irons crossed against the lug wrench as shown in the illustration. A few drops of penetrating oil should be applied to the lug first. The method should not be used in tightening lugs, as it will set them tighter than needed.—A.R.



FOR CAR OWNERS

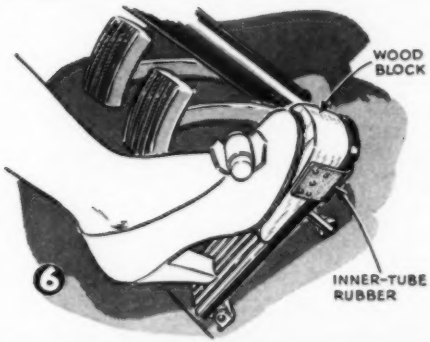


5 **A CAR WHEEL STUCK IN SAND** is freed easily with the technique illustrated at the left. Dig a small hole for the bumper jack and raise the wheel as far as possible. Then shovel or kick as much sand under the wheel as you can, packing it in. Deflate the tire to around 12 or 14 pounds. Remove the jack and you will be able to drive the car away under its own power.—J.D.

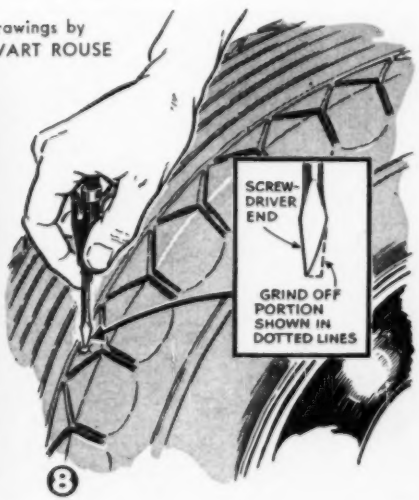
6 **WITH A TOE REST** slipped over the accelerator-pedal tip, women wearing high-heel shoes will find car driving much easier. Cut from a block of wood to a comfortable size, and held in place by a strip of rubber or leather, the toe rest raises the instep and relieves the ankle of strain.—A.H.W.

7 **MANY MOTORISTS PREFER** not to use their rear-view mirrors at night. An ingenious, glareless substitute is afforded by small colored reflector buttons cemented to the center strip of a divided windshield. Car lights from far behind strike all the buttons; close behind, they strike only the top ones, thus indicating their distance to the driver. Remove the bolts from five-and-dime-store buttons, apply mending cement, let it dry, then reapply cement and attach the buttons, for a firm hold.—R.P.

8 **A HANDY TOOL** for digging bits of glass, sharp stones, and the like from tire treads is made by grinding away a portion of the blade of a pocket screwdriver, as illustrated below.—W.E.B.



Drawings by
STEWART ROUSE



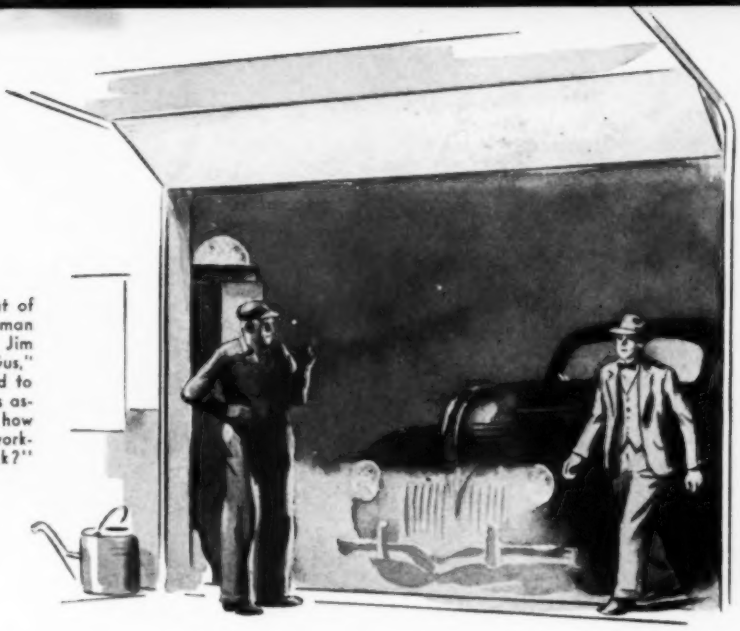
Auto Ideas

BRANDED TIRES, with brand markings burned into the tire sidewalls, are urged by one tire manufacturer as a safeguard against tire theft, and motorists getting service from the company's dealers get their tires branded free of charge. The brands, put on by an electric tool, correspond to the license number of the owner's vehicle, simplifying tracing through motor-vehicle registration bureaus.

With the stenciling kit above, motorists may mark their tires (right) for identification

A TIRE-MARKING KIT which enables the motorist to paint his own tires with his name, initials, or car license number, consists of a set of stencils, a bottle of marking paint, a special felt applicator, sandpaper, and instructions. The same kit may be used for marking bicycles, mail boxes, refuse cans, golf bags, coaster wagons, sleds, boats, and fishing boxes.

REMOVING STUCK CYLINDER HEADS is reduced to a matter of minutes with a new product that is easy to use. The stud nuts are first removed and special threaded plastic cups are screwed on the studs. Rubber seals at the bases of the cups make a leakproof contact with the engine head. A liquid chemical is then poured into each of the cups. After a few minutes, the fluid is removed with a bulb-type syringe and the cups unscrewed. The head then lifts off easily, the penetrating chemical having broken down the corrosion bond that commonly makes the head stick to the studs. The material works with either aluminum or iron heads, and the cups are available for 7/16" or ⅜" studs. Forced removal of the heads can result in breakage. This method is safe.



It stopped in front of the door and a man got out. It was Jim Fraser. "Howdy, Gus," he greeted. "Glad to see you, Jim," Gus assured him, "but how come you're not working tonight? Sick?"

GUS brightens 'em up

The Model Garage proprietor knows his cars and customers well enough to tell in a flash which one—car or customer—needs some careful doctoring

By MARTIN BUNN

IT WAS a warm evening. Along about nine o'clock Gus Wilson, who was working what in prewar days he would have called overtime but now considers normal hours, lighted his pipe and stepped to the open shop door to breathe in a few lungfuls of fresh air.

After he had been standing there for five minutes he saw a car turn off the highway and come up the Model Garage drive. It stopped in front of the shop door and a man got out. It was Jim Fraser, a small, red-haired, middle-aged man who used to clerk in Henry Miller's hardware store but who now works nights in charge of the stockroom of a war plant five or six miles from our town.

"Howdy, Gus," he greeted. "Saw your lights burning, and thought I'd stop in for a few minutes."

"Glad to see you, Jim," Gus said. "But how come you're not working tonight? Sick?"

"Eyes have gone bad," Fraser said. "I can't see like I used to. Specially when I'm driving at night. I'm going to see an eye doctor tonight—only time we could get together—and get myself fixed up with specs. I hate like the dickens to wear them."

"Huh," Gus said. There wasn't any sympathy in his voice because he was remembering something that he had noticed as Fraser had driven up the driveway. "Do you have any trouble seeing at night when you're *not* driving?" he asked.

"No—now you mention it," Fraser admitted. "But my eyes sure are bad when I'm on the road after dark, and if I don't get specs I'll be wrecking my old bus some night."

"Got 15 minutes to spare?" Gus asked.

"Sure," Fraser told him. "I didn't know what time the eye doctor would get through with me, so I phoned the plant that maybe I wouldn't get there before eleven or twelve. Why?"

"Drive your car into the shop," Gus said, "and I'll show you something. It isn't your eyes that have gone bad. It's your car's lighting system."

"There's nothing the matter with my lighting system—not a thing!" Fraser said almost huffily. "Of course, it ain't as good as these sealed-beam headlights the new cars have, but I can't afford to buy a new car."

"You can't afford to be driving a car when you can't see where you're going, either,"

Gus told him. "Even if you're willing to risk your own neck, you haven't got any right to risk other people's. You don't need a new car any more than you need spectacles. What you do need is to have enough work done on your lighting circuit to make it as good as it was when your car was new. Drive her into the shop, Jim, so I can get a better look at her headlights."

Fraser drove his car into the shop. "Switch your lights on the high beam," Gus told him. He did it, and then got out and went around to where Gus was standing in front of his car. "When you came up the driveway from the road," Gus said, "I noticed how dim your headlamps were. There are a half dozen things that cut down the efficiency of a car's lighting system, and I miss my guess if every one of them isn't the matter with yours!

"To start off with, one lens is cracked so it lets in moisture and dirt that tarnish the reflector. I couldn't swear to it without opening the headlights, but I'd bet ten to one that your light bulbs are pretty close to being burned out. And I'd make another ten-to-one bet that you've got some bad connections in your lighting circuit. Now let me show you something."

He went over to his own ancient but immaculate roadster and turned on the lights. Then he switched off the shop lights. "My bus is five years older than yours is," he said, "but I keep my lighting system in good condition. Take a good look at your headlights, and then take a good look at mine."

He waited long enough for Fraser to do his looking, and then switched on the shop lights. "It's up to you, Jim," he said then. "Which do you think you'd better spend your money for—a pair of spectacles that you don't need, or enough work on your lights to stop your being a public menace?"

"Have it your way," Fraser growled. "I'll bring my bus in on my way home from work tomorrow morning, if I can have it back by six o'clock in the evening."

"O.K.," Gus said. "And I'll guarantee that when you drive out of here tomorrow night you'll think you've grown a new pair of eyes."

When Gus got down to the shop next morning he found Wally, the grease monkey he is trying hard to turn into a mechanic, staring lazily at Fraser's '39 sedan. "What's the matter with this one, boss?" he asked between yawns.

"Lights," Gus said briefly.

Ten minutes later Wally came over to his bench. "Say, Boss," he reported, "I can't find anything the matter with those headlights except that one lens is cracked."

"You can't?" Gus asked. "How about the bulbs? Nothing wrong with 'em?"

"They burn all right," Wally declared. "I tried 'em."

"I know they burn," Gus told him. "Bring 'em over here, will you?"

Five minutes later Wally came back with the bulbs. "Here they are," he said. "I had a heck of a job getting the headlights open."

Gus grinned. He glanced at the bulbs, and then took a sheet of white paper out of his workbench drawer and placed them on it. "See how black they are? Bulbs blacken as they grow older, and the blacker they get the less light they put out. These are done for—put new ones in."

"O.K.," Wally said. "What else'll I do—put in a new lens?"

"Yes, but let me take a look before you do it," Gus said and went over to Fraser's car with him. He examined both the headlamp lenses closely, and then both the reflectors. "See anything wrong here, Wally?" he asked.

"Sure," Wally said. "Both the reflectors have lost their shine, one worse than the other."

"That's right, they have," Gus agreed. "But that isn't what I mean. What style lenses are these—what's the name on them?"

Wally read the name molded in the glass: "RiteWay."

"Correct," Gus said. "Now, what name is stamped on the reflectors?"

Wally peered intently into the opened headlamps. "FlexBeam," he read after a few seconds.

"Right again," Gus told him. "But the combination *isn't* right.

BUY WAR SAVINGS BONDS AND STAMPS

Then Gus switched off the shop lights. "My bus is five years older than yours is," he said, "but I keep my lighting system in good condition. Take a good look at your headlights, and then take a look at mine."

To get the best results you've got to use lenses and reflectors of the same style, or the same trade name. Fraser must have had his lenses replaced some time, and didn't get the right ones for his reflectors. Put in new lenses, but make 'em FlexBeams."

"New reflectors, too?" Wally wanted to know.

Gus took the reflectors out of the headlamps and looked them over carefully. "No," he decided. "These reflectors aren't bent or dented—they're just tarnished pretty badly. You often can remove tarnish by polishing them the right way. I'll show you how to do it."

Gus took the reflectors over to his workbench. From the shelf above it he took down a small can and a small bottle. "This is lampblack," he told Wally as he opened the can and poured some black stuff out into a clean saucer. "This is pure alcohol," he went on, uncorking the bottle. "You pour enough of it on the lampblack to make a thick paste — so fashion."

He took a package of absorbent cotton from his workbench drawer and rubbed a small piece of it in the lampblack paste. "Watch now," he told Wally. "Polish this way—lightly out from the center of the reflector. Never polish *around* the reflector. Go to it," Gus told him.

Twenty minutes later Wally, grinning triumphantly, held up the reflectors. "They're as good as new!" he announced.

"Well—not quite," Gus qualified. "But they're good enough to do a decent job for quite a while. Be careful that you don't touch their bright surfaces while you're putting them back in the headlamps. Oh, another thing—be sure to use new gaskets when you install the new lenses."

Toward the end of the afternoon, Gus got out his headlamp tester and checked the brightness of the lamps. "You did a good job, Wally," he told the grease monkey. "But they still aren't as bright as they should be. My guess is that there's a voltage drop somewhere in the lighting circuit. That's always bad—a 10-percent loss in voltage means a 30-percent loss in candlepower. I'll have to do some checking."

Using a bulb-socket voltage adapter and a voltmeter, he found that there was more than a 10-percent drop in voltage between bat- *(Continued on page 218)*

GUS SAYS:

Fifty feet of old garden hose will provide enough rubber for a Navy inflatable life raft. Two old inner tubes will make three heavy Army gas masks. One hot-water bottle will—well, you get the point. Turn the stuff in, Brother, so that Uncle Sam can use it!

CHILDREN MAKE EXCELLENT PHOTOGRAPHS if you catch them posing naturally. Above and on the facing page, the props are simple and the little subjects are engaged in everyday amusements. Study the two pictures, then turn to the accompanying article by a Hollywood photographer of children and see how easy it is to get results you can be proud of

PHOTOGRAPHING *Children*

By CHARLES LAMONT

Director, Universal Pictures Corporation

Charles Lamont knows children, and how to photograph them. He has filmed boys and girls of all ages, from babies-in-arms to teen-agers. It was he who first photographed Shirley Temple, directing this young star in 11 two-reelers. Baby Sandy later came under his direction for four pictures. At present he is directing Michael Barnitz, 2, and Gloria Jean, 13, in a series of features. This is his background—an impressive one—in photographing children.

HOW can you get a cute snapshot or movie sequence of the baby? How can you trick youngsters into posing or following certain desired action? What props help make pictures interesting?

From my experience in directing movie youngsters, through diaper- to teen-age, in a score of feature pictures, I recommend that you follow one cardinal principle: no matter what pictures you desire, let your young subject be perfectly natural. Because no two are alike in personality, endeavor to stimulate the interest of the one you are photographing, and let nature take its course. I guarantee that from a hundred feet of film or a dozen negatives you will record a pose or bit of action that will delight your family even after the prints grow old and faded.

For purposes of photography, I should separate children into four age groups. Below 14 months, from 14 to 18 months, from there to 3½ years, and then up to about 13 years. Obviously the first group cannot take direction. With the "crawlers" all you can hope to do is catch them sitting in an overstuffed chair playing with the dog or a doll, crawling about on the floor, sleeping or playing in the crib.

In the second stage, simple tricks will bring the desired action. To get the child to walk through a door and toddle across the room, hide something he likes. If it's fruit, say, "Go get the banana, Sammy," and baby usually will do the rest. Speak to the youngster like an equal. At this age, he is beginning to reason.

You may not want your child to cry, yet a crying scene, judging by the reaction of theater audiences, holds a very great appeal. More than once I have drawn big tears and lusty sobs from babies by sending their mothers away on some pretext. After the scene was shot, I suddenly remembered needing the mother, and in the baby's presence asked an assistant to call her back, giving the reason. In a few minutes, the mother stepped back onto the stage. The point is, I made the episode logical and kept the baby's respect. They're smart little

EASTER—and what is more appropriate than Easter bunnies and bright, colored eggs? Arrange your lighting and props ahead of time; then catch the child at the first delighted expression, as when she handles an egg. Note how props help frame the interest

devils, and it's wise never to forget that.

From 18 months to 3½ years, the baby will react with increasing skill to simple directions, and above 3½, begin to react to fairly complicated direction, speak lines, and take a part along with adults. In many, many instances, these youngsters "wow" audiences, whether in the theater or in an amateur movie at home, because they're not worried about their appearance.

If you have a choice, set up your lights and camera in a room having light walls. A word about lights: Make sure the illumination is not sufficiently intense to injure the baby's eyes. A photoflood No. 4 may not be hard for you to look at, yet it may trouble the baby, for it is photographically 2½ times more powerful than an ordinary 1,000-watt bulb. It's a good plan to screen the lights with translucent gelatin diffusers. A No. 52 cinema daylight blue is my choice. Daylight-blue tracing cloth is an excellent, inexpensive substitute.

Keep the lighting simple, using straightforward, balanced, front lighting, and avoid back light and other tricks. To achieve an excellent effect, permit the sun to stream in through one window, or place one or two photofloods outside the window, directing the beams from their polished reflectors along the wall to suggest sunlight.

Be prepared to waste a little footage, if you really want to get the cutest shots. You can't direct a baby under 14 months old. Have the lights on when you bring the baby in, and make sure you start filming during his regular playtime. Never disturb his sleep or rest, for he likely will be fretful and perhaps even ill-tempered. Place him in the area covered by the camera, and simply let him go. To attract his attention in any desired direction, switch on an extra light. Do not move rapidly around the room; avoid sudden noises, and don't place the camera so near him he'll want to investigate the purr of its mechanism.

If possible, for both movies and stills, place the baby about three feet from the background. Place the movie camera to cover any desired area, but take stills from a distance of three feet. As he grows, move the still camera back to about five feet. Make all still pictures full figure. Should a head picture be wanted, enlarge that area from the negative, thus avoiding possible distortion and insuring good focus.

Either flood lamps or flashes may be used for stills. I prefer the latter, shooting usually at 1/100 second to stop normal action. If you use only one flash lamp, have it at the camera and turn the baby toward the shadow so the profile will stand out. Should you prefer a double flash, direct the one at the camera toward the subject and the other from the opposite side upward against the background. A third light, preferably a flood, may be directed against the background from a point opposite the second

HALLOWEEN AND PUMPKINS always go hand in hand, and the scene at left is no exception. Overalls, straw hat, and carved pumpkin face help to emphasize the season. Note here, too, how much interest the props add

FOR THANKSGIVING try to get a pose like that below—it won't be hard on the family bird if it is rescued in time. Risk is well paid by that look of surprise when a previously loosened drumstick pulls off

or background flash bulb.

Flash lamps are covered with a shatterproof coating, but I'd take no chances when working close. It's a good plan to cover each reflector with two cellulose-film envelopes; they prevent injury should a lamp break and also diminish the intense light.

Birthdays and seasonal dates always suggest ideas for both stills and movies. Simple props will help commemorate the occasion. The accompanying pictures of Baby Sandy suggest several ways of putting atmosphere in the pictures according to the season represented.

New Year's. We dress Sandy in diapers, shoes, and socks, fasten a merry-maker's hat on her head with an elastic band, give her a horn to wave, and place her against a wall festooned with streamers and balls of colored paper.

Easter. The baby is dressed like a bunny and

placed among colored eggs. Two rabbits, one at each side, frame her near the center.

Halloween. She sits on dry corn stalks wielding a huge knife and preparing her own pumpkin. Two uncut pumpkins at right and stalks at left again help frame her in the center.

Thanksgiving. What better prop than a turkey? Cut one drumstick so the child can pull it loose easily. Set up to shoot across the bird into your tiny subject, and the instant she jerks the leg off the carcass, shoot. No direction is needed. You'll catch an expression of surprise or pleasure impossible to get by carefully posing the picture.

You need not confine yourself to seasonal pictures, however. Let him peep into the refrigerator or the stove for some dessert he enjoys, and catch him in the act. Let him hold the telephone, and have another child call from next door. Shoot at the instant he hears the voice. If you want him to look in a certain direction, have mother hold the teddy bear exactly where you want him to turn his eyes. And don't, for heaven's sake, comb his hair and dress him in a new bib-and-tucker. You'll prize that dirty face 20 years from now.

A single sequence may be delightful, but why not treble the interest by developing a little scenario? You'll need a little time to shoot and cut the reel, but patience will bring a great reward of enjoyment through the years.

The scenario, or shooting script, need not be elaborate. You can scratch it down on an envelope. I can suggest an outline, and you may fill in with added scenes or make such changes as you desire.

Suppose you open with a flash of the baby asleep in his crib. Cut to the corner of the room, where the dog lies sleeping. Back to the baby, who stirs and opens his eyes. Now to the dog again, who rises to its forefeet. Return to the baby, and catch a big, sleepy yawn. Now the dog yawns. Arising slowly and stretching, the dog moves to the crib.

Baby can't get through the day without mother's and daddy's presence; but we wish to confine our interest to the child, so we virtually eliminate the grownups. We catch a pair of feminine feet walking—in slippers to keep the mood of early morning. Now the feet approach the refrigerator, and a hand takes a milk bottle from the shelf. A flash shows the baby crying. The dog rests its paws on the covers. A hand enters, placing the rubber nipple in baby's mouth.

From this beginning, you proceed according to your own ideas through the day. Hands lift and undress baby for his bath. A parrot peeks at the proceedings. The dog looks up. Baby naps in the buggy. At dusk, two masculine feet enter the front door. Two masculine hands lift baby. You can see baby bouncing on a trousered knee. At last, baby is asleep once more.

Here you have the basis of a genuinely human story.

About that nap: there's only one way to photograph a child sleeping, and that is actually to get him asleep. The sweetest shot I ever got of little Michael Barnitz showed him deep in slumber. Set up your lights and camera, focusing on a doll placed in the spot your little actor will occupy. When the room is darkened, have mother place the baby in bed. When he is fast asleep, tiptoe in, turn on the lights one at a time, and photograph the scene. Should he wake, and you want him to turn his head, snap on a light in the opposite direction. It's that simple! And you'll have a never-to-be-forgotten picture.

Naturalness—that's the aim of all children's pictures, both movie and still. Freak lighting may change baby's photographic personality, and therefore I say, don't juggle your lights, but shoot straight. Put children on celluloid as nearly natural as they are in real life.

NEW YEAR'S GAIETY forms the inspiration of this photograph in which the child wears a clown's cap in best New Year's tradition and waves a horn against a background of colored streamers

Processing Movie Film at Home

WITH LOW-COST EQUIPMENT

By S. Y. CALDWELL

THIS film-processing outfit was made from a 3-gal. butter crock and a 3-gal. tin milk cooler costing together less than a dollar.

The reel holds 27′ of 16-mm. film. Four rows of 1″ wire brads driven through from the inside of the can are secured with a drop of solder over the head of each brad. They are clipped off on the outside to a length of ¼″ and the ends finished smoothly with a file.

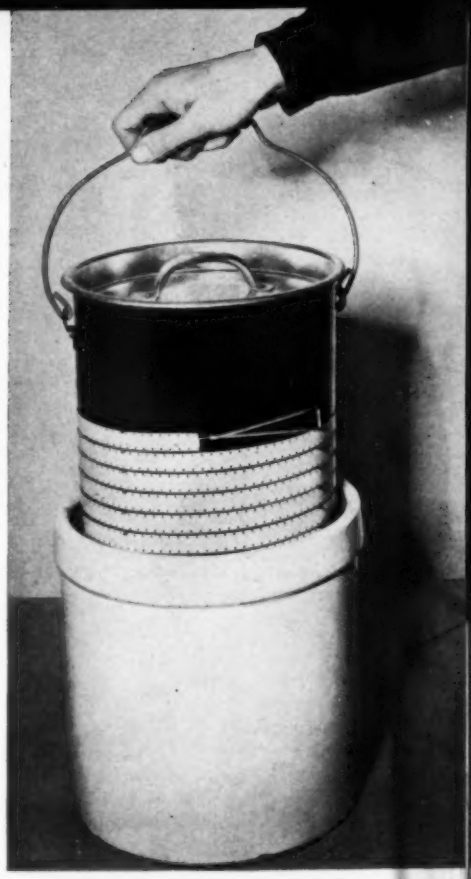
The pins must be spaced to allow film to pass between them without touching, and are staggered from row to row to take a continuous spiral of film. A coat of black photo enamel over the outside of the reel and the pins completes the job.

In use, the drum or reel is filled with water at the same temperature as the photographic solution is to be, the lid is put in place, and the film is wound on emulsion side out. At each end it is hooked over an ordinary pin bent fishhook fashion and tied to a rubber band that is then looped over two of the reel pins.

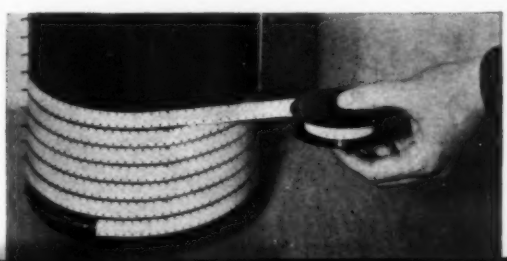
Developer is poured in the crock tank, and the loaded reel is lowered into it. Two quarts are required for the tank illustrated. Agitation is obtained by turning the reel at intervals. The film expands when wet and becomes slightly loose, but the pins prevent it from overlapping.

Between treatments, the reel is lifted from the tank and placed in a bucket of water for rinsing while solutions are being changed in the tank. An alternate method is to have a separate crock for each solution, since the crocks are cheap. Film may be washed while still on the reel, but it should be removed for a final rinse, wiped, and hung on a rack or other device for drying.

The water inside the film drum serves not only to weight it down, but also to hold chemical solutions in the tank at a constant temperature. Developers oxidize slowly because little of them is exposed to air. The film is completely immersed throughout development, which eliminates aerial fog. Both reel and tank are easy to keep clean. Processing can readily be done in total darkness, as is necessary whenever fast panchromatic film has to be developed.



Two quarts of developer suffice with this tank. The reel holds water, which helps to maintain solutions at the right temperature

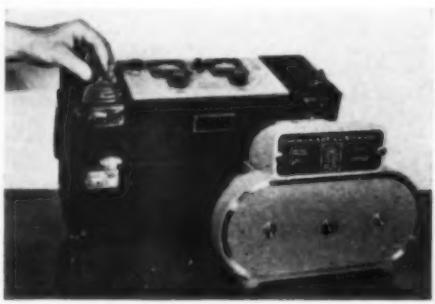


Brads are soldered in place from inside as shown above, then cut to length and filed smooth. Black photo enamel is applied all over the exterior. A bent pin and a rubber band hold each end of the film, which is wound on, emulsion side out, as at the left

FOR CAMERA USERS

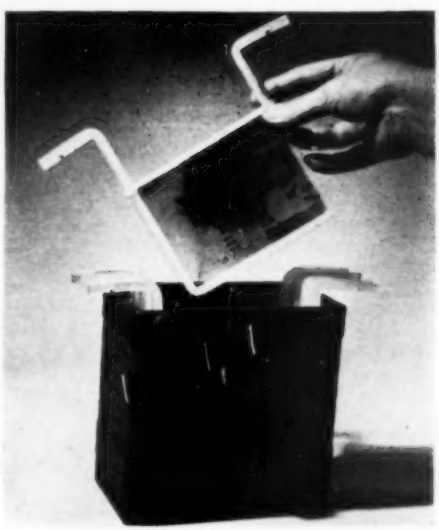
THIS ALL-PLASTIC film viewer takes standard color slides or 35-mm. film. It has a lens that affords considerable magnification, and a detachable diffusing window. The curved top of the case permits the corners of slides to project, making removal easy. Slides of any thickness can be inserted, whether in paper, glass, or metal mounts, yet no focusing is required for viewing either these or film.

Either mounted slides or 35-mm. color film can be inserted in this viewer

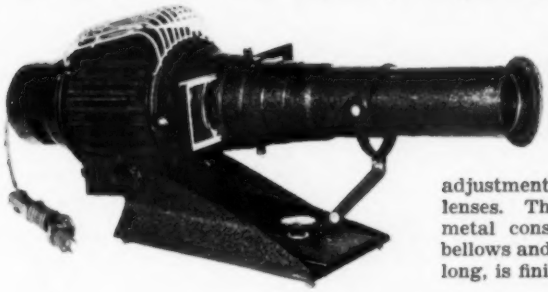


A SOUND-ON-FILM RECORDER for 16-mm. black-and-white and colored movies has been designed by E. M. Berndt, G. A. Bush, and Walter Bach, of Hollywood, Calif., for producing sound movies at comparatively low cost. It takes standard 200-foot daylight recording film, and carries meters indicating correct exposure settings. Its case also serves as a sound-insulating "blimp." Operating cables are plugged into connections on the outside, these being so arranged they cannot be hooked up incorrectly. A pilot light in a small window indicates whether the recording lamp is burning. Amplifier and batteries, supplying enough power to record several thousand feet of film, are carried in a second case. Tubes are of low-drain type. Two dynamic microphones may be used, and sounds mixed to blend on a single track. The recorder is intended for use with any electrically driven 16-mm. camera.

PLASTIC NEGATIVE HANGERS (below) are available in four sizes to fit $2\frac{1}{4}$" by $3\frac{1}{4}$", $3\frac{1}{4}$" by $4\frac{1}{4}$", 4" by 5", and 5" by 7" films. They have no clips or other moving parts and, being chemically inert, are unaffected by acids and photographic solutions. The holders may be used with any type of open developing tank. Their glasslike surface will not scratch negatives, and laboratory tests have indicated that they are practically unbreakable.

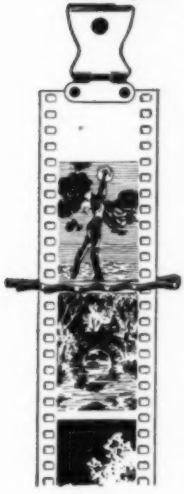


Built-in Motor Cools Heavy-Duty Projector for Glass Slides



FORCED-AIR cooling provided by a built-in motor is one feature of a new stereopticon that shows standard glass slides. This makes it possible to use projection lamps of from 250 to 1,000 watts. A special socket aligns any lamp and allows for adjustment of the beam to suit different lenses. Three lenses are furnished. All-metal construction includes an adjustable bellows and a wire guard. The projector, 30" long, is finished in black wrinkle enamel.

Bobby Pins Keep 35-mm. Film Straight While It Dries



WHEN a strip of 35-mm. film is hung up with a weight to keep it from rolling up while it dries, it often takes on a curl from edge to edge. One way to overcome the trouble is to clip a bobby pin across between two frames every five or six inches. The film should first be swabbed off in the usual way to prevent water streaks. With this method a strip dries as flat as cut film. The weight on the bottom is, of course, employed in the usual way to prevent it from rolling.—F. W. TABER.

Wetting Agent Cleans Lenses Without Hard Rubbing

AUXILIARY lenses and filters can be cleaned without danger of scratching by the use of a wetting agent such as is added to developers. Moisten a soft cloth or a piece of lens-cleaning tissue with it, swab the lens carefully, then rinse and dry it off very gently.—KENNETH MURRAY.

Slotted Viewing Boards Aid in Editing of Color Slides

EASILY made viewing boards of the type illustrated enable a large assortment of color slides to be viewed and edited with a minimum of handling. Short ends of wide boards or other scrap lumber can be used in making them. Each board is 1" by 12" by 18". On a circular saw, parallel grooves 3/16" wide and 3/8" deep are cut 2" apart the long way of the piece, the entire top surface of which is then painted white. One such board will hold about 48 slides. Light from overhead is reflected by the white surface, against which the slides stand out clearly. When not in use, several boards can be stacked to take up little space, so they offer no great problem even where room is scarce.—WILLIAM L. MORGAN.

HOME AND WORKSHOP

Priorities won't stop you from building this all-wood game for lawn or basement

Roll-a-Disk

A TWO-IN-ONE LAWN GAME ANYONE CAN MAKE

By
Charles and Bertram Brownold

HERE is a new lawn bowling game, made entirely of wood, that provides exciting sport and good exercise for grown-ups as well as young folks.

Instead of balls, fairly heavy disks of wood are rolled, or bowled, and the game is played in two different ways. One resembles tenpins, but in place of turned pins, hollow wooden pins that are square in cross section are used. In the second version, the same disks are bowled at a large wooden pen having openings of various sizes. Bowling the disks into the narrow openings counts a higher score than getting them into the wide openings. When the game is played with the pen, the tenpins are not used.

As all of the equipment is light and portable, the game has another advantage—it may be played outdoors in fine weather and moved indoors at other times. It is a grand game for a basement playroom, gymnasium, "rumpus room," cellar, barn, or any place where the noise won't prove objectionable. Any reasonably smooth playing surface will do, but a grass lawn, for which the game was really designed, is best of all.

All of the equipment is easy to make. Either hard or soft wood may be used. The former is a little more costly, but will wear better. While it is not necessary to adhere precisely to the dimensions given in the drawings, doing so is an advantage if the lumber is to be bought at a local yard, because the dimensions have been correlated to stock lumber sizes, which means a minimum of waste and cutting for the craftsman.

Disks. While only three disks are needed, it may be convenient to make more. A few extra ones will speed up play, as then the player need not wait for the pin boy to send them back to him. Each disk is made of two circles of wood 1" thick and about 12" in diameter, cut on a scroll saw or band saw, if available, otherwise with a compass saw. These circles are glued and screwed together, with the grain of one at right angles to the grain of the other. Six flathead screws

Disks are rolled from a distance of 30' into openings of various sizes in a pen. Each disk is made from two pieces of wood screwed together as shown below. Details of construction for the scoring pen are also given in the drawing

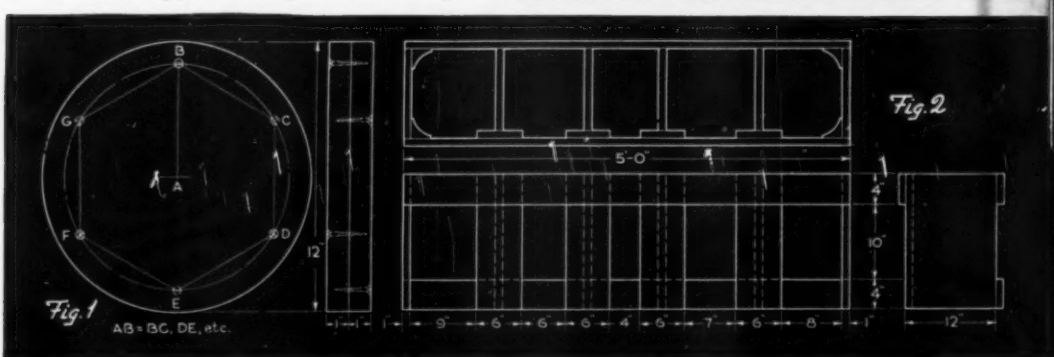


Fig. 1

Fig. 2

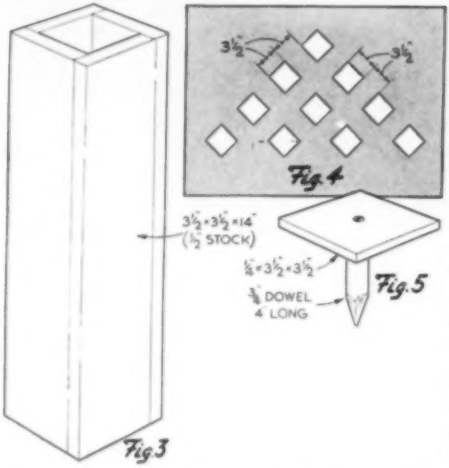
Tenpins are used instead of the pen for another exciting game. They are hollow wooden squares, as in the drawing, and when used on the lawn are stood on plywood-topped pegs

in constructing the pen.

Tenpins. These are made of ½" wood, and each is a bottomless, topless box with outside dimensions of 3½" by 3½" by 14".

A good way to make the tenpins is to screw together four strips of wood to form a long square tube and then saw the tube into 14" lengths. When screwing the strips together, be careful not to place screws on the lines where the saw cuts are to be made. Figure 3 shows the construction of a pin.

Pen. The pen is made of 1" lumber as shown in Fig. 2. One of the photos shows how the corner braces are screwed on the nearly completed pen.



Pegs. Ten pegs are needed if the tenpin game is played on grass, particularly if it is rough stubble. Each peg is a 3" or 4" length of broomstick or dowel, to one end of which is fastened a 3½" square of plywood. The other end of the peg is sharpened to a point so that it can be thrust into the ground and the plywood square pressed down into the grass. The purpose is to provide a level base for the tenpins, as well as guide marks for setting them up each time they are knocked down. Figure 5 shows a peg and its plywood square, and Fig. 4 illustrates how the tenpins are set up. The pegs are not needed if the playing surface is smooth dirt, for then markings can be scratched in with a stick. If the game is played indoors, marks can be chalked on the floor.

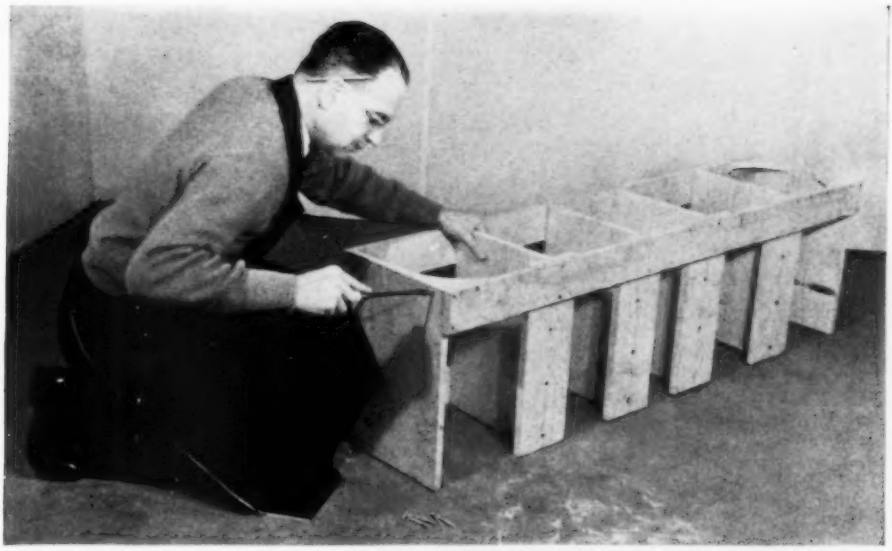
Painting and decorating. After the equipment is made, it should be well painted. It may then be decorated in various ways with transfers, decorative tape, and brightly colored geometric patterns painted on with the aid of masking tape or stencils.

A handy way to paint the disks is to drill holes through their centers. A rod is then thrust through the holes and mounted as shown in one of the photos. This makes it possible to paint both sides as well as the edges of each disk in one operation.

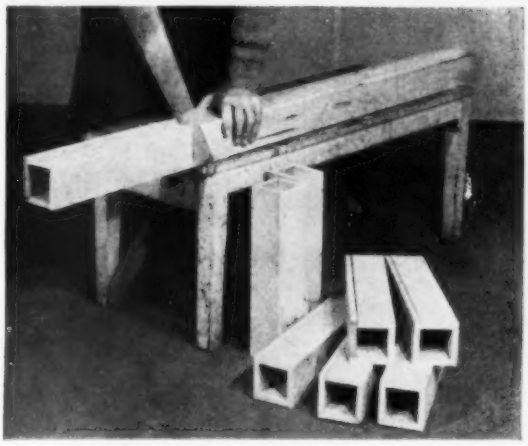
If it is decided to decorate the game with

are used in each disk, three from each side. They are countersunk and placed equidistantly in a circle about an inch from the edge of the disk. In order to space the screws evenly, draw an 11" circle on the disk and without changing the set of the compass strike off six equal arcs on the circumference (see the drawing marked Fig. 1).

When cutting the wooden circles, do not throw away the corner pieces that fall off, as these can later be used as corner braces



Both pen and pins are of the simplest construction. Waste left from sawing the disks is used for bracing corners of the pen as shown above. In making pins, time is saved by screwing strips together, then sawing to length (right)



a stenciled pattern and stencil paper cannot be obtained, so-called "oak tag" of the kind used for filing folders is excellent when saturated with linseed oil. Cut the stencil before applying the oil.

Stencil brushes are not sold in all paint stores and some of them are expensive, but an old shaving brush with its bristles cut evenly to a length of about 1″ will do very nicely. When stenciling, work with a fairly dry brush so that the paint will not flow under the stencil and blur the outline of the design.

To stencil the tenpins, clamp a stick to the worktable and slip the hollow tenpins over it, one after another. Thus all four sides can be handily stenciled, and the tenpin can be stood on end to dry.

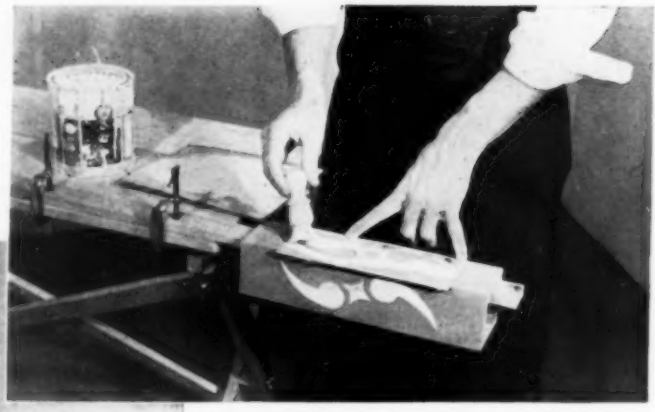
Playing rules for tenpins. Set up the pins as shown in Fig. 4, and about 40′ away peg down a tape or chalk a line, depending on whether the game is played indoors or out. Players bowl from behind the line, and also take turns as pin boy. The duties of the pin boy, as in regular bowling,

HOW MUCH LUMBER TO ORDER

16′—1″	by	12″	dressed	white	pine	or oak
6′—1″	by	6″	″	″	″	″ ″
16′—1″	by	4″	″	″	″	″ ″
50′—½″	by	3″	″	″	″	″ ″

Note: Cost of clear white pine in New York, $5.72; oak, $9.46. Paint, hardware, and incidentals, about $2 extra.

Easy methods of painting pins and disks are shown at right and below. If any stenciling is done, a shaving brush with the bristles cut down can be used to apply paint. All surfaces of the disks can be finished at once with the setup illustrated



are to roll back the disks, remove "dead wood," and set up the pins after they have been knocked down. The rules and scoring are the same as in bowling.

Rules for bowling at the pen. Peg down the tape (or chalk the line) about 30' from, and parallel to, the pen. Each player bowls three disks each time he is up. The winner is the player with the highest total score at the end of a predetermined number of rounds. Each time that a player comes up, he may have his choice of two different scoring methods. In the first method he is credited with the aggregate total of the numbers appearing over the openings into which he bowls his disks, thus:

4"	opening—	80 points
6"	"	50 "
7"	"	40 "
8"	"	30 "
9"	"	20 "

In the second method of scoring, should he elect to use it, he must announce which opening he intends to try for. If he makes it, he gets double the number of points marked above the opening. If he fails to make it, he gets no score, even if his disk enters another opening.

As in the tenpin game, the players take turns as pin boy. The pin boy must lift the disks out of the pen so that they do not obstruct the next roll. He must also remove from in front of the pen such disks as do not enter. He rolls the disks back to the player waiting at the tape.

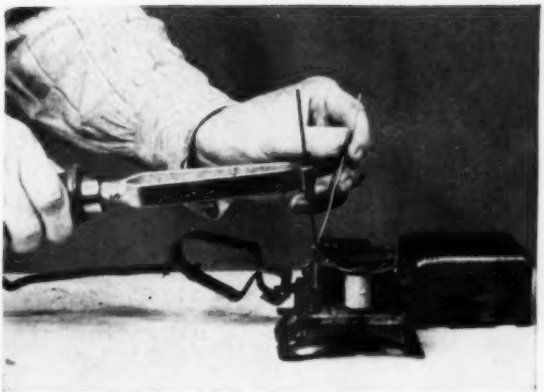
Steel Wool Kept Under Water So That It Won't Rust

SINCE the United States entered the war, I have found that steel wool, which is used in Army kitchens to clean pots and pans, is hard to get. I tried to conserve its use and discovered that if the steel wool is submerged in clear water each time after using it, a single wad will last a full month. Being covered with water, the steel wool does not come into contact with air and therefore will not rust.—Staff Sgt. A. M. BAKER.

• • •

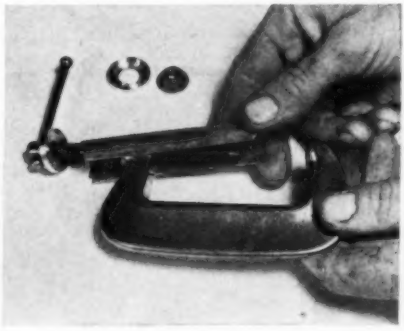
WOODEN rollers, such as those on which ticket tape is wound in some bus fare registers, cash registers, and the like, make wheels for small toys if sanded, sawed to the desired width, and glued on dowel axles.—F. D.

NEW SHOP IDEAS

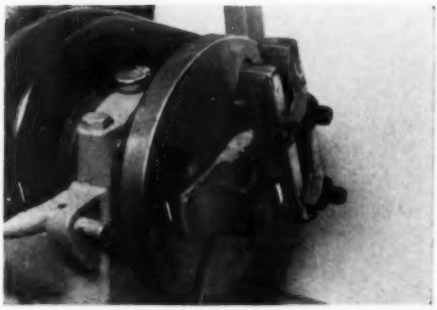


SMALL PARTS BRAZED EASILY. Delicate welding on small electrical or radio parts and jewelry can be done more easily with an electrode consisting of a length of pencil graphite. This piece of ordinary No. 1 or 2 lead pencil, sharply pointed at the working end, will reach into places not accessible to even a small carbon. The lead can be obtained by burning away the wood from a pencil, or a long mechanical-pencil lead may be used. Because of the small diameter of this lead, however, it is impossible to clamp it in most carbon holders. An efficient adapter can be formed from a 1" length of ¼" copper or brass rod. File a narrow flat along the rod and then, using a triangular file, cut a groove lengthwise of the flat. The standard carbon holder will then clamp both the adapter and the pencil lead securely, as shown in the photograph above.—W. C. WILHITE.

SHIELD PROTECTS WELDER'S CLAMP. Slipped over a clamp that is used for holding parts to be welded, this easily made shield protects the clamp screw from spatter and, as a result, insures easy removal when the job is completed. The shield consists of a split piece of light metal tubing and two recessed cap washers that are quickly turned on the lathe to the proper size to fit the clamp. Twist off the clamping foot at the end of the screw, assemble the guard as shown in the right-hand photograph, and rivet the foot back in place. It is advisable to braze the cap washers to the tubing, so that the shield will not be likely to slip out of them.—B. N.



U-STRAPS FROM JUNKED MAGNETS. Highly serviceable heavy-duty U-straps for bolting work to the faceplate of a lathe, or to the table of a milling machine, can be made quickly from discarded magnets of the type used in the flywheel magneto of a once popular light automobile. Simply become your own blacksmith and heat the V-shaped piece to a cherry red; then hammer the ends together until the legs are parallel. This U-strap will be found to be especially useful for securing odd-shaped work. Magnets of this type can be found in the older auto wrecking yards, and in many a junk pile.



Cornice Boxes

AND CURTAIN POCKETS

By Joseph Aronson

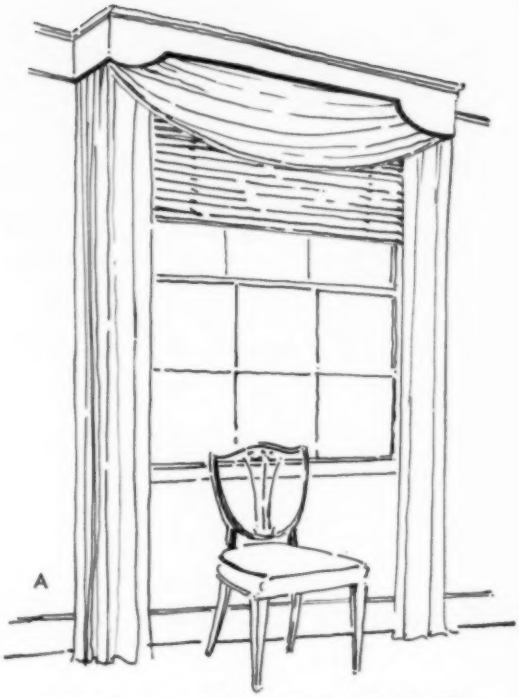
Author of *The Book of Furniture and Decoration*

THE handy man around the house sooner or later finds himself involved in interior-decoration problems, particularly those involved in hanging draperies. This may be his opportunity to display an unexpected knowledge of the design basis of draperies and curtains.

Important draperies should be considered in terms of an architectural frame for the window. Thus, in the impressive type sketched at *A*, the window cornice is treated as an extension of the room cornice. The size and dignity of the window are enhanced by extending the cornice beyond the width of the window. This has another and even greater advantage in that less of the actual window area is obscured. Light and air are thus gained, as indicated more clearly in the diagram marked *B*. Very often it is advisable to make the cornice deep enough to receive the Venetian blind or shade as well as the drapery, as shown in the cross-section view sketched at *C*. This permits the blind to be drawn up *over* the window head, and so opens even more of the window. And now that blackout shades are so frequently required where it is vital to have the opaque material cover *over* the casings, a wide cornice is really essential.

In a low room in which you want to make the windows more important, always build the cornice box right up to the ceiling, as illustrated in sketches *A* and *B*. On the other hand, if the ceiling is fairly high, the cornice box may be placed between the window head and the ceiling.

In either case, a closed cornice is preferable, as it is easier to install and also protects the curtain heads from dust. The best construction is to rabbet the top part into the upright or skirt as shown at *D*. However, when applied moldings are used, a simple butt-jointed construction *(E)* is satisfactory, as the joints are covered by the moldings. A mitered corner is most professional, but if you want to round the corners you may just butt the ends and round off as indicated in the detail marked *F*.

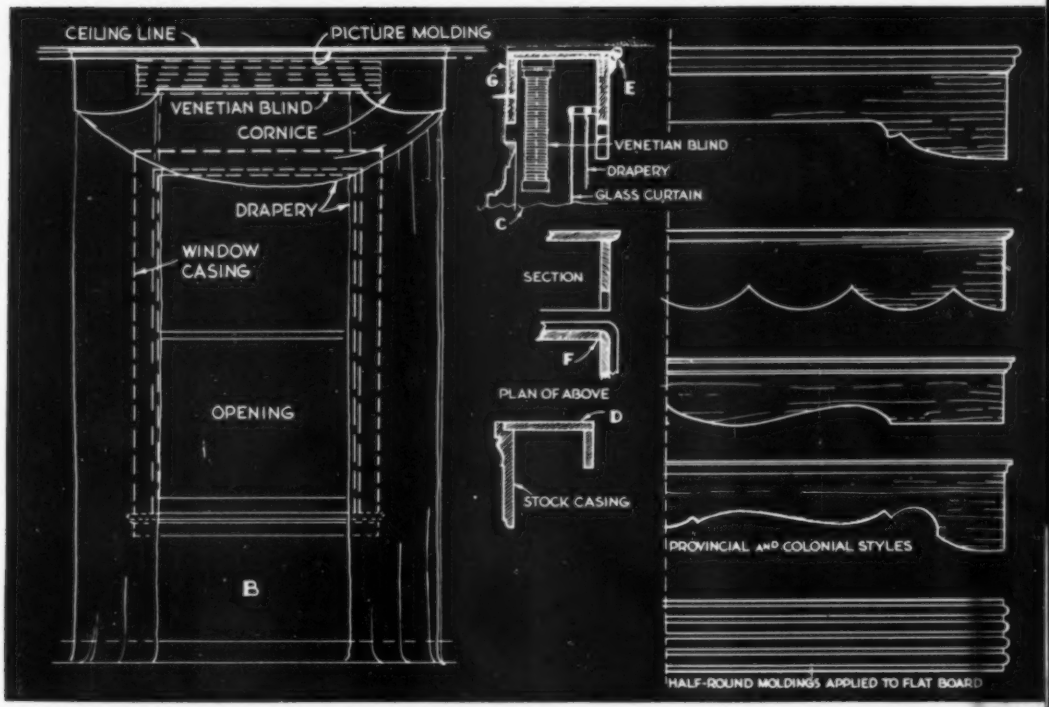


Windows in a low room become more important with a cornice built up to the ceiling. The one above is made deep for a Venetian blind as well as drapery

Most lumberyards have a selection of good profiles in stock moldings. Even door casings and baseboards, looked at from another angle, will often suggest a good cornice molding.

A very simple cornice box may be made by capping a flat board with a piece of the same picture molding used in the room. This should be placed at the same level as the picture molding, so as to "break out" over the cornice. In this style of cornice a cut-out skirt is good, and several profiles are suggested in the drawings on the facing page. Four of them will be found in general good taste for almost any type of room, but the bottom one should be chosen only if the treatment of the room and furnishings is in the modern manner.

The simplest way to install the cornice box is by providing it with a back, marked *G* in the detail sketches, and driving screws through this back where they will catch studs in the wall. If the cornice box is tightly put together with glue in all the joints, the leverage developed will not be too great,



Another trick is to extend the cornice beyond the width of the window, thus enhancing its size and dignity. To the right are construction details and several designs

even with heavy curtains. Angle irons also may be added for additional support; use 3″ by 3″ or 4″ by 4″, according to the size of the window.

The treatment selected for finishing should make the cornice either part of the walls or of the drapery construction. Never paint the cornice so that it will stand out conspicuously alone, as it would do if it were of a contrasting color. Occasionally it is possible to use a finish that recalls or resembles the wood of the furniture, but unless this is of light color, the cornice box is apt to appear heavy and unrelated to the window design.

In provincial type rooms—Early American, French, Scandinavian, and the like—a complete curtain pocket is sometimes interesting. One design incloses the sides and top of the window in a complete frame, as sketched at *H*, with the base forming a shelf or sill on which plants and ornaments may be arranged.

Oil Applied to Tools with Dauber

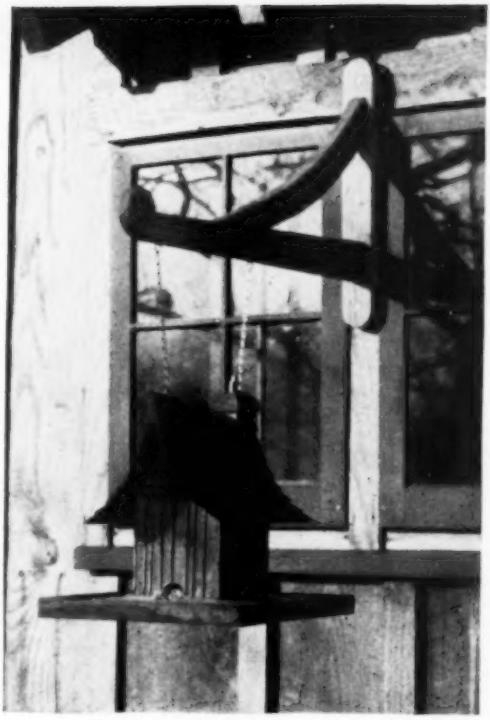
WASH out a shoe-polish bottle and dauber in solvent, put in light machine oil, and keep this handy for applying a thin film of oil to the cutting edges of the lawn mower, sickle, saw, and other tools after use. This will keep them free from rust.—W. D. MCMILLAN.

THIS ATTRACTIVE

BIRD FEEDER

BRINGS THEM RIGHT UP TO YOUR WINDOW

By W. A. Conway



A GREAT deal of pleasure is to be had from observing birds that are attracted to the house by a feeder of the type illustrated. It holds several pounds of seeds, which are automatically dispensed. This particular design was worked out for use with a house of English architecture, but the style can readily be modified to suit other conditions.

Make the base of 1" chestnut or other suitable wood, 13" square, and cut a long bevel around the top edge so as to leave a 6" square, or flat surface, in the center. Then cut three drain notches in each edge of the base before trimming the edges with ½" by 1¼" strips.

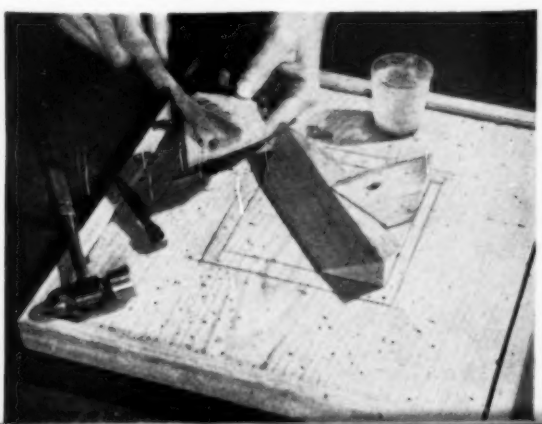
The board-and-batten effect on the sides of the feeder is obtained by cutting ⅛" wide grooves at random intervals along one face of a 36" long board. Strips ⅛" by ¼" are cut to fit these grooves, and fastened in with waterproof casein glue or plastic resin glue. The four sides are then cut from the prepared board, and the battens are shaved off or removed where the weatherboarding is to be added on the gables at each end. Glue on this weatherboarding.

For the seed distributor, a triangular strip is prepared as indicated in the drawings. This is cut into three pieces to fit on the base, as shown in one of the photos, then glued and nailed in place. Next, the walls are fastened to the base with waterproof glue and brass escutcheon pins. The latter are used to prevent rust streaks.

The curved roof surface can be made in several ways. The feeder illustrated has a roof of galvanized iron with a covering of chestnut strips. The metal could, of course,

The chimney cap is removed to fill the feeder with seed, as illustrated below. The plug must be loose enough to allow for swelling when in place

Three pieces cut from a triangular strip are glued and nailed to the base to form the seed distributor. Top of page, the finished feeder hung on a bracket



be replaced by ¼" thick horizontal wood strips, with the bottom ones of sufficient width to give enough overhang.

The feeder is filled through the hollow chimney, and this is nailed in place from the inside before the roof is attached to the walls. Automotive trim cement is used around the chimney base to prevent leaks. Make the chimney plug loose enough to allow for possible swelling when in use.

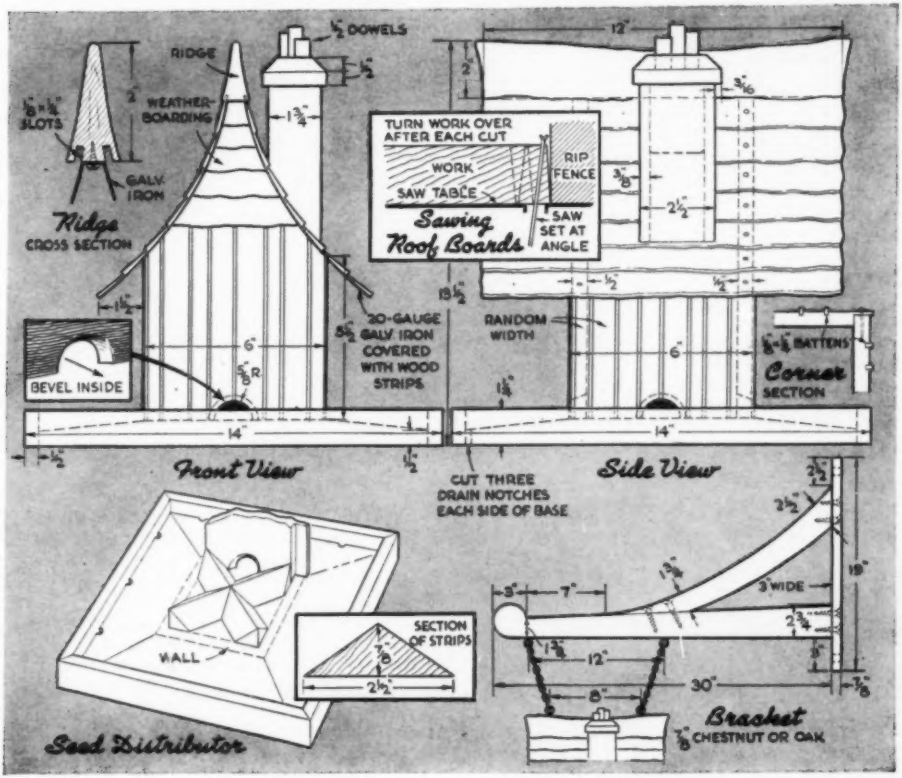
Rip the roof covering from 1" stock, using the method shown in the drawings to get a wedge-shaped cross section. Cut an irregular edge on the exposed side of these strips and fasten them to the roof with small brass nails. The strips on the overhanging edge can be cemented with trim or running-board cement, which is highly tenacious. Apply a coating to both surfaces, dry until tacky, and press into place.

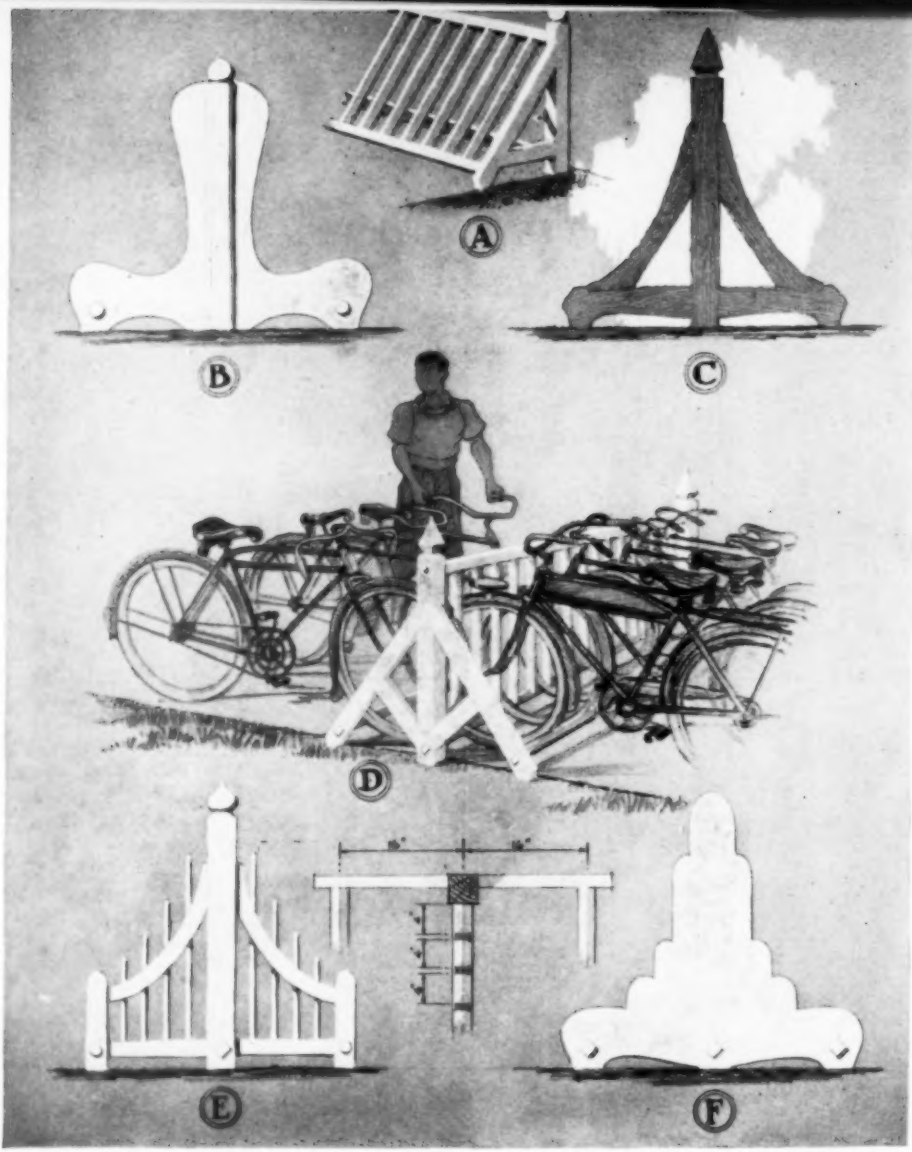
Use dark brown stain on the roof, gables, and the edge of the base. Leave the remainder a natural light brown. The entire feeder is then given three coats of boiled linseed oil. This should be allowed to soak in completely, with a 48-hour drying period between coats.

The feeder can be mounted on a post, or hung from a bracket or other support by means of two chains fastened to screw eyes in the ridge, and left up the year round.

Sunflower seeds seem to be the favorite of most birds, although cracked corn, wheat, and other grain can be mixed with them. Avoid substances such as bread crumbs, which may clog the feeder when damp.

Above, applying cement on the galvanized-iron roof before covering it with chestnut strips, as below





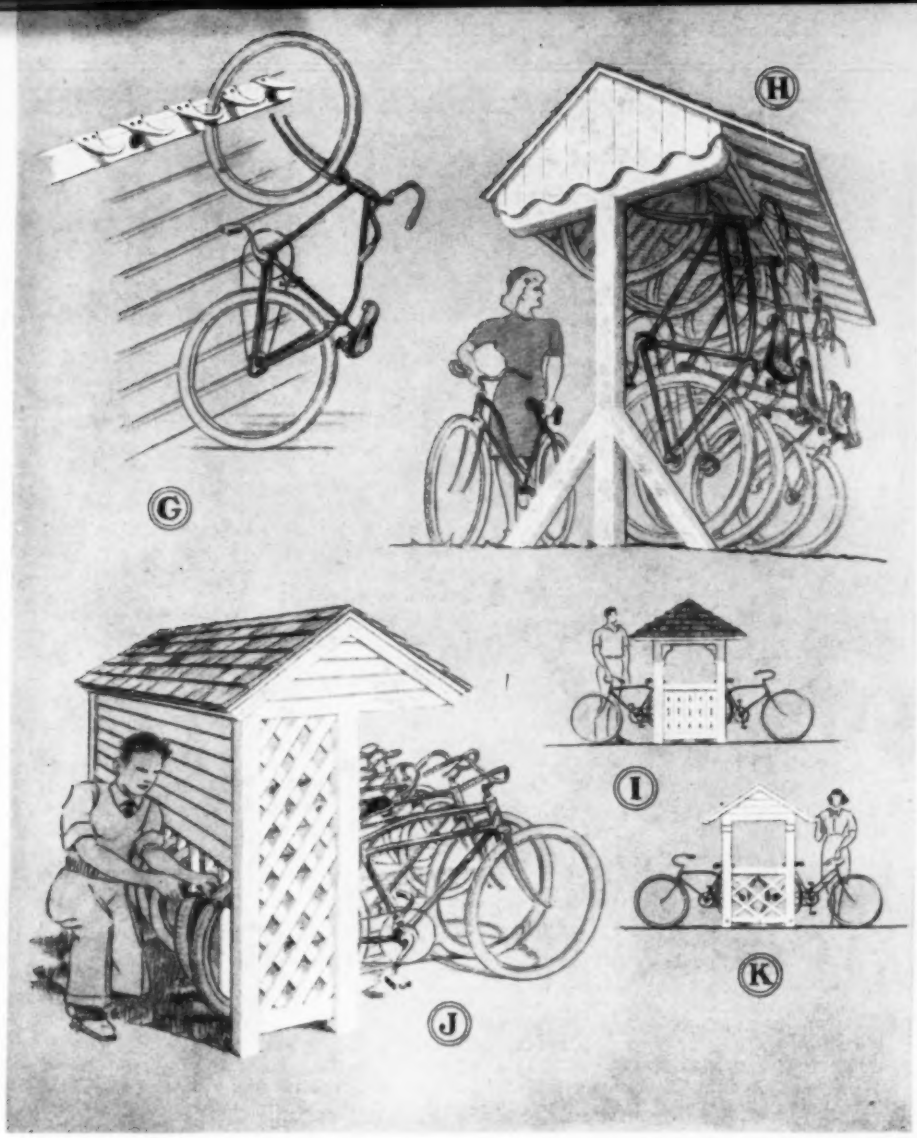
Half a dozen simple racks that blend with their surroundings. They may be made to hold few or many bikes

Bicycle Racks

ELEVEN ATTRACTIVE DESIGNS FOR EVERY PURPOSE

NOW that the bicycle has returned as a major medium of transportation, a new parking problem arises. Many readers have asked for plans for bicycle stands.

Ernest Stevens, a Washington, D. C., architect, offers a timely answer with eleven designs of wood bicycle racks ranging from simple to elaborate. These designs have been approved by the Cycles Trades of America. All of them are suitable for public places and lots



Five more racks. With the exception of G, they have roofs which are decorative and give protection

of one kind or another, and most can be adapted for private use on home grounds.

"It is estimated that there are around 11,000,000 bicycles in use in the United States," says Henry Meloney, secretary of the Cycles Trades. "That's about the same number as there were motor cars in 1923, and about one to every three cars in 1941, or one to every 13 persons.

"The frame of a bicycle will last about 20 years; the wheels, four to five years; and the tires are good for 3,500 to 5,000 miles. A bicycle needs little attention, but, unlike an auto, cannot be left unattended. It requires a lock and a rack. Racks are badly needed at railroad stations, shopping centers, defense plants, or wherever people gather for war work or recreation. Racks can most economically and efficiently be built of wood, a noncritical material."

Incidentally, bicycle manufacturers are now experimenting with wood as a material for building certain parts of bicycles such as handgrips and pedals.

CIVILIAN-DEFENSE + Litters

By COL. F. T. CHAMBERLIN
Surgeon, Second Armored Corps

FOR the past year it has been my privilege to give instruction in first aid to the Red Cross Motor Corps of Lake Charles, La., a group of women organized for rendering assistance in the event of a local or national emergency.

Seeing that this organization had great need of some type of litter, the writer started a little "jackleg" experimenting to devise a light, strong, practical one that might be easily made at little or no cost, and that would collapse to occupy little space in the family jalopy, where the latter is still on the hoof.

Two types were constructed and thoroughly tested against the standard Army field litter. The first, of scrap galvanized pipe, was found to be a little too heavy, but would be excellent if made from salvaged aluminum or duralumin tubes. Our test litter consists of two 48" lengths of 1½" and two 48" lengths of 1" galvanized pipe, one of each size being used for each pole. A ⅜" hole was drilled 1" from one end of each piece, and a 5/16" bolt was secured with a light piece of chain and an 8-32 machine screw to each of the two 1½" pipes. The bolt is 2¼" long and passes through a large and a small pipe to secure them when telescoped.

Another ⅜" hole was drilled 6" from one end of both 1" pipes. When the litter is to be used, the smaller pipe is pulled out until only 7" of it remains in the other, and the bolt is used to lock both together in the extended position.

A piece of salvaged canvas 33" wide and 78" long was hemmed along both edges, and the litter poles were shoved through the seams thus formed.

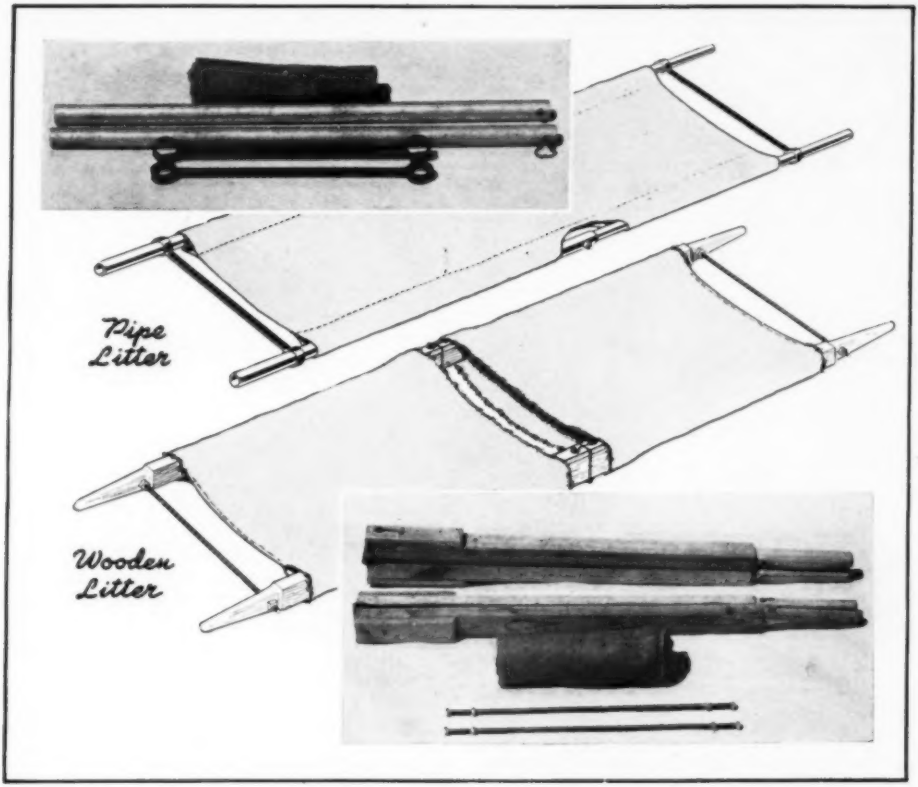
Two "spreaders" were made by bending 2" circles at the ends of 36" long pieces of ¼" by 1" cold-rolled steel. Slipped over the poles, these held them about 24" apart, preventing the weight of the patient from pulling the poles together, and making the work of the litter bearers considerably easier.

A lighter, even less expensive, and more easily constructed litter was made of four pieces of 2" by 4" yellow pine 45" long, ripped to a width of 2⅛". Handles 9" long were shaped with chisel and pocketknife on one end of each piece.

Two 6" strap hinges fastened with 2" screws join two pieces to make a pole 90" long when opened. Blocks ⅞" by 1⅝" by 9" are nailed opposite the hinges on each piece, as shown in one of the photos. These blocks butt against one another when the sections are opened. They strengthen the joint and permit the use of smaller poles, particularly if oak or maple is available.

To hold the poles rigidly in the extended position, two ordinary screen-door hooks are attached across the joints on the side opposite the hinges.

An inexpensive litter cover was made of two salvaged burlap sacks. The seams were opened for 3" at each corner along the bottom and the sacks were slipped over the handles, one behind the other. Thus this litter cost the large sum of 40 cents. Only a saw, hammer, screw driver, chisel, and knife were needed to complete it, and the job was done in 23 minutes. Of course, if canvas can be had, it can be hemmed as described for



Two inexpensive types of litters that are easily constructed and fold compactly. If new canvas cannot be obtained for covering either litter, two salvaged burlap sacks will serve the purpose adequately

the pipe litter, or tacked on the wood poles.

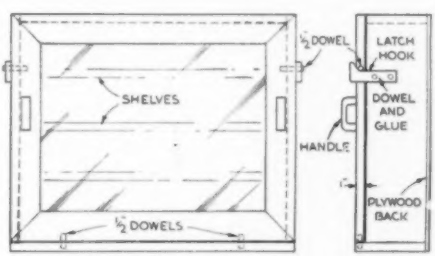
For spreaders, two ⅜″ round iron rods were threaded on each end for 2½″ and a nut was run up to the end of the threads. Holes were bored through each handle, the rods inserted, and a second nut screwed up on the outside with the fingers.

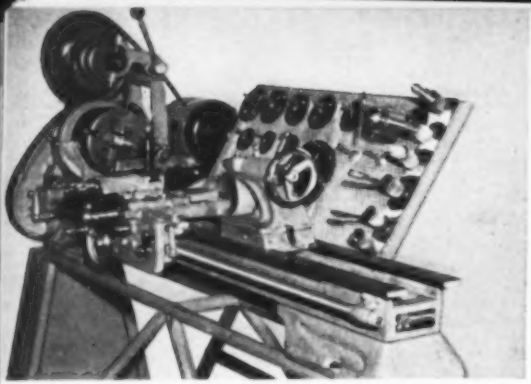
Either of the litters described will fit crosswise on the floor of a car when folded, or in a good-sized luggage compartment.

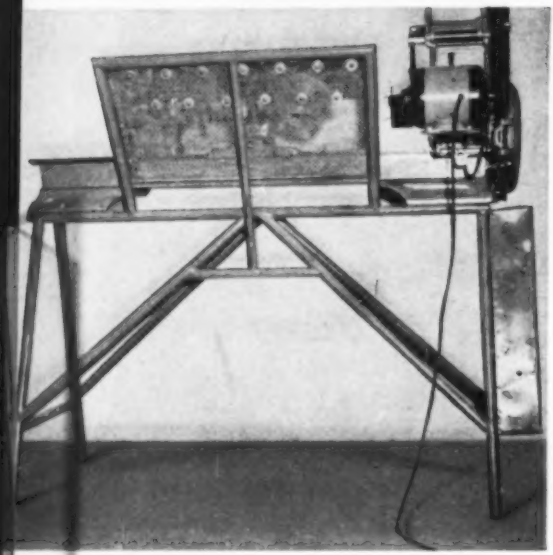
Roomy First-Aid Cabinet Constructed with Self-Locking Door

NO METAL fittings are used on this first-aid cabinet, which is suitable for air-raid posts, public buildings, schools, and homes. The door drops into place in such a way that children cannot readily open it.

Dimensions are omitted from the drawing, since the cabinet can be built in any desired size. The sides and top of the original one were made of 1″ by 6″ stock, but the bottom of the cabinet should be 1″ wider, or 1″ by 7″ in this case. Use 1″ stock for the door members also, rabbeting or grooving these for the glass. Plywood may be used instead if the cabinet is to be located where it may be subject to concussion, but a glass panel leaves the contents visible at all times.—FRED WEBSTER.







Old Electrical Conduit Welded into Durable Lathe Bench

THIN-WALL conduit of the 1" size, either new or used, makes a neat, durable stand for a bench lathe when welded together, as shown in the accompanying photographs. It affords ample leg room for working close to the machine, it cannot accumulate chips like a bench, and is easy to sweep under.

Notch and miter the corners of the rectangular top section; then weld the legs to it. Reinforce with braces, as shown. A sheet-metal box welded to one pair of legs may be fitted with shelves for small accessories such as tool bits, centers, and the like. A frame, also of conduit, may be welded to the back member of the top for a tool rack. "Tack" wire mesh to the framework. On this ¼" stove bolts may be fastened with nuts and washers in any convenient spacing to hold threading gears, faceplates, chucks, and other accessories. This stand is more convenient and portable than a bench, and it makes the lathe handier to operate.—E. S. HARRIS.

Acid and Sal Ammoniac Flux for Soldering Stainless Steel

STAINLESS steel is often difficult to solder without a special flux. As an alternative, common cut acid may be applied to the seam and a few grains of powdered ammonium chloride (sal ammoniac) sprinkled on the acid to make the solder flow freely. I have found that ordinary half-and-half solder will then give a satisfactory joint on this material.—FLOYD KOWALAK.

ELECTROPLATING WITH CADMIUM [ELECTRICAL]

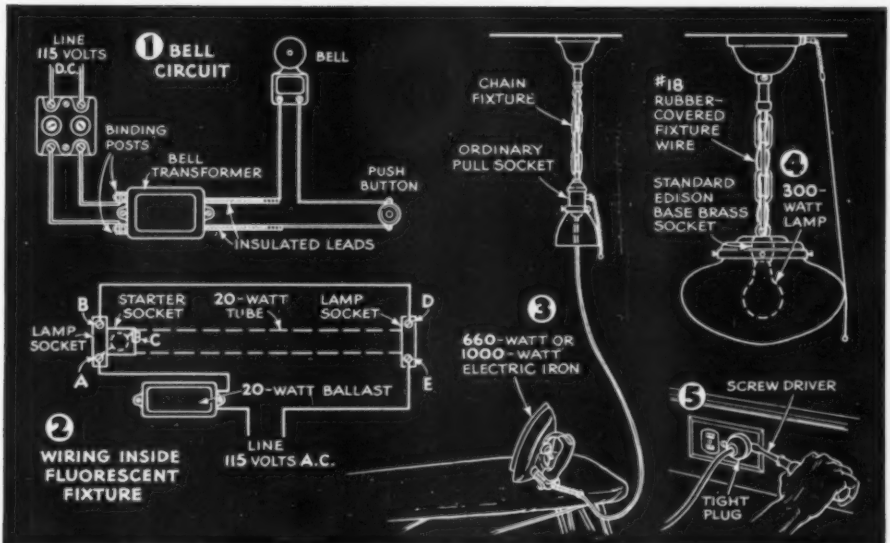
Cadmium is plated from an alkaline solution. A typical formula is prepared by dissolving 11 oz. sodium cyanide (POISON) in 1 gal. water, and adding 5 oz. cadmium oxide, made into a paste with water. When dissolved, add ½ oz. dextrine, which will improve the smoothness of the deposit.

Cadmium anodes are made in sticks and balls, the former being preferable for small-scale use. As the metal passes into solution faster than it is deposited, the rate of anode efficiency should be controlled by (1) suspending only a part of the anode in the solution, or (2) adding an iron rod, smaller than the anode, which will pass more current into the solution.

As cadmium deposits more rapidly than copper, it is well to start with a low voltage and increase the current up to 3 volts, or until the deposit has a tendency to darken. The plating should be a brilliant white color. If it does not deposit with sufficient whiteness, 100 grains of nickel cyanide (POISON) may be added to each gallon of solution. Dissolve the nickel salt in 1 oz. water; then add a strong sodium-cyanide solution to dissolve the precipitate that is first formed. Add this solution to the bath.

When the deposit is heavy, cadmium is a good protection against corrosion. It can be given a high polish, but will not withstand much handling, in that it marks easily. The surface can be protected, however, with a thin application of furniture wax. When corrosion protection is desired, rather than a bright appearance, cadmium plating can be alloyed with the base metal merely by heating. This will cause the cadmium to sink into the pores of the base. The metal can be used as an undercoating for nickel plating in place of the usual copper deposit. An alloy of cadmium and zinc, readily deposited from a single solution, combines the good properties of both metals.

POPULAR SCIENCE MONTHLY SHOP DATA



What's Wrong?

NINE ELECTRICAL ERRORS FOR YOU TO DISCOVER

HOW good are you at electrical trouble shooting? Here are five problems professional electricians might encounter. Should you connect a bell transformer as in Fig. 1, you'd be in for trouble. There are two mistakes. Can you point out two errors in the fluorescent-lamp hookup in Fig. 2? You may have seen a flatiron used as in Fig. 3, but there is one thing wrong all the same. Figure 4 illustrates a ceiling fixture open to criticism on three counts. Can you name them? Finally, Fig. 5 shows a common nuisance—a sticking plug, which is being pried out from a wall outlet. What mistake is illustrated? Turn the page upside down to read the answers.

1. (a) A transformer must never be connected to a direct-current line. (b) The insulated leads should go to the 115-volt line; the bell wiring to the posts.

2. There is no circuit through the ballast, starter, and lamp filaments, such as is necessary to start the lamp. (a) The wire connected to *B* should go to *C*. (b) The one at *A* should go to *B*. No wire connection should go to *A*, which is joined to the starter socket by a strap.

3. A flatiron draws enough current to overload an ordinary 250-watt brass socket and common fixture wire. Heating and insulation breakdown may occur.

4. (a) A mogul base is standard on 300-watt lamps, and would not fit an Edison, socket. (b) Heat from a large lamp inside a globe will deteriorate the fiber lining of a brass socket. A porcelain socket should be used. (c) Heat-resisting wire (type AF) is required for a fixture intended for a large bulb, and No. 16 is preferable to No. 18. Rubber-covered wire should not be used where it may be subjected to heat.

5. It's dangerous to use any metal object; a short circuit is likely. Use a wedge-shaped piece of hardwood.

Solution for Removing Enamel from Fine Magnet Wire

WHEN the enamel has to be removed from very fine magnet wire to permit connections to be made or soldering to be done, it is sometimes impractical to use a knife or even fine sandpaper or steel wool, either because of the delicacy of the wire or the position in which it is located. In such cases the enamel can be removed by applying a solution of one part ethyl alcohol, one part benzol, and one part ammonium hydroxide—a formula developed by Alfred Bellis, chief electrical engineer of John A. Roebling Sons Company.

• • •

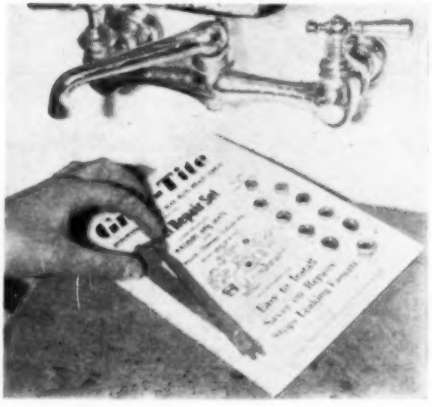
A NEAT-LOOKING platform flag stand can be made from a junked automobile steering wheel. Ream the hub for a piece of pipe, which forms the flagpole socket.—G. E. H.

IDEAS for HOME OWNERS

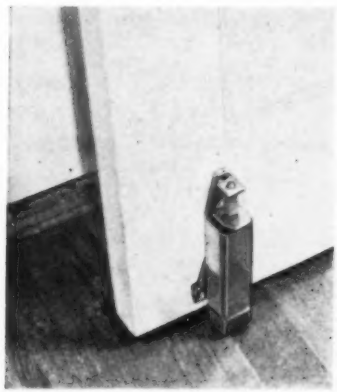
PLASTIC-COATED WALL PANELS, available in the three designs shown at the right and in ten colors, have been developed for new home construction and for remodeling. The sheets, coming in sizes up to 4' by 8', are prefinished with the plastic surface permanently bonded to the base by treatment with heat. Recommended installation is by means of a waterproof adhesive, but brads may be used if the old wall permits. The covering is suitable for walls and ceilings of kitchens, bathrooms, playrooms, and the like, is waterproof and stainproof, and may be cleaned readily with soap and water.

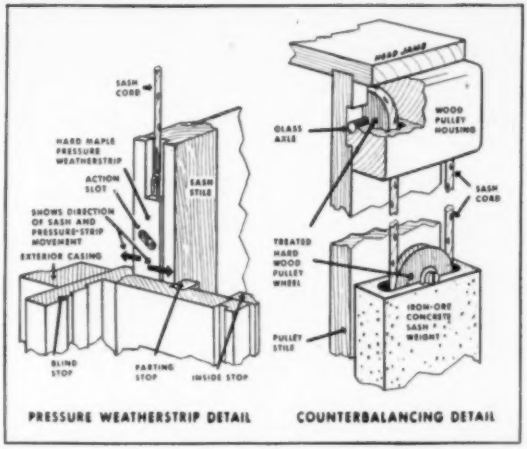
RUST CAN BE REMOVED QUICKLY from light fixtures, door hardware, household appliances, automobile bumpers, and other metal-finished parts with the use of a new liquid available in small, handy bottles. The fluid is merely spread over the rusted part, allowed to remain for about two minutes, and then wiped off with a cloth or steel wool. Two applications may be necessary if the rust is deep. If the surface is to be repainted, it should dry for 24 hours. Wax will help preserve unpainted pieces. Steel wool or a stiff brush soaked in the liquid is said to clean brown spots off vitreous enamel.

FAUCET SEAT AND WASHER are combined in the leak-repair kit shown below and will be found of help especially in stopping persistent leaks where a washer alone will not do the work efficiently. The gadget resembles a cork with a hole in the center and takes the place of the old washer and screw. Composition material used in the seat is designed to expand and seal water crevices or pits in worn faucets. Six common household sizes are supplied on a card, together with a convenient tool for installing the parts.



ONLY MODERATE FOOT PRESSURE is required to give the door holder below a firm grip on the floor and provide a secure anchorage against slamming. Its specially designed plunger pushes down on a small roller, which becomes wedged with a slight motion of the door and locks it against further movement in either direction. Release is equally easy by tripping a foot latch. The door stop is less than 8" in length, and comes in die-cast metal in a bright or a brushed bronze or brass finish, in dead black, or in a natural finish similar in color to nickel.





PRESSURE WEATHERSTRIP DETAIL — COUNTERBALANCING DETAIL

DOUBLE-HUNG WINDOW UNITS using less than 8 oz. of metal where 25 lbs. have been needed before are on the market for efficient, cost-saving home construction. Pulley wheels and housings are of treated hardwood; pulley axles are of tempered glass instead of steel; sash cords are used in place of chains; and weights, formerly of cast iron, are made of concrete composed of iron ore and cement. A new weatherstripping principle is employed in the design, automatically forcing the sash against the parting stop of the frame by a counterbalance action which translates the vertical pull of the weights into horizontal pressure. The new window is completely prefabricated and is adaptable to many types of wall construction, and to remodeling as well as new work.

THIS CANDLE LANTERN for use in emergencies gives out an adequate soft light without glare in any of three colors—red, green, or clear—by a simple turning of the inside holder with the thumb or finger. To effect this, the glass container, which holds a renewable, heavy, squat candle, has three equal divisions, each finished in one of the colors. It fits loosely in a metal casing having a rectangular cut-out in front through which the light is emitted. Narrow openings are provided in the top for air vents. The lantern is only 6½" high, 2½" in diameter at the base, and 3¾" across at the top.

Equipped with a handle for easy carrying, this lantern provides a safe emergency light. The candle is lit, put into its casing, and then turned to the desired color

Plenty of action is a feature of this automatic target, which will keep the marksman shooting for five minutes at a time. Spent air-rifle shot can be recovered from a trap at one side

AUTOMATIC Air-Rifle Target

By C. ELMER BLACK

AN AIR rifle and this automatic action target, which runs continuously about five minutes at one setting, will guarantee hours of fun and some lively, competitive target practice. One ball at a time runs down the zigzag course and, whether it is shot off or rolls all the way to the bottom, automatically starts another. Shot that strikes the runways is deflected and cannot rebound toward the marksman, while any that misses both the balls and runways passes through a cardboard backstop and drops into a chute, from which it may be recovered for further use. The balls may be bought at most toy counters.

Groove the two sides for the backstop before nailing the box together. Fit the plywood front pieces, and insert the runways from the back. These may be of angle iron or bent from scrap strips of medium-weight sheet metal. Fasten them with wood screws to notched wooden blocks, and screw these fast to the plywood frame as in the drawing.

Bevel the top of the tapered piece *C*, so that the piece *H*, when nailed to it, will slope forward in the box as indicated. Nail the second piece *H* to the bottom of *C* and fix the latter in place. The shot-return chute is then attached directly to what has become the sloping bottom of the target box.

Wire from a coat hanger will do for the parts of the ball release. Mount the trigger loosely over the hole in the upper piece *H*, using two small staples. Solder the release parts to a piece of tubing as shown in one of the photographs; then slip the tubing over an 8-32 bolt passed through the plywood front, and secure it with a nut. Join the trigger and release with a strong cord, adding enough nuts or washers to the release lever to keep it in the closed position.

Drop several balls through the top opening and observe their action, bending the release or trigger as required so that only one ball may start down the runway when a spent ball trips the mechanism.

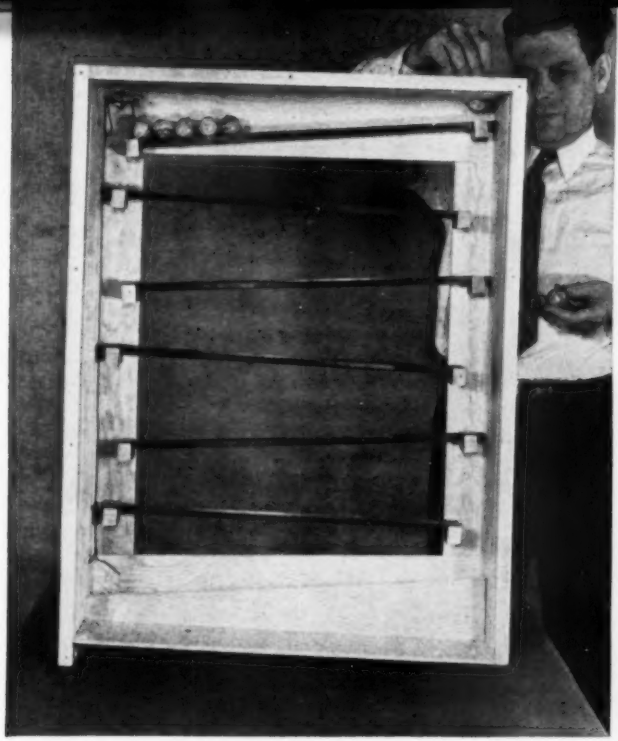
Screw the rear sidepieces to the backs of the runway blocks, slip a piece of corrugated cardboard into the grooves in the sides, and paint the box flat black outside. To use it, hang the target level at a height of 5′.

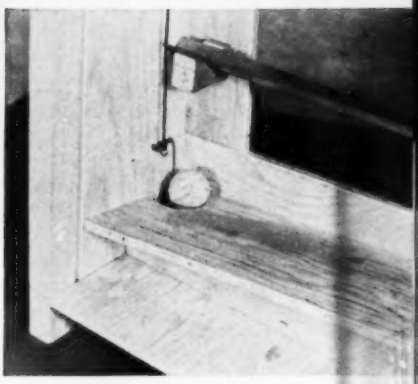
LIST OF MATERIALS

No. Pc.	Description	T	W	L
2	Sides A (pine)	¾	5⅜	32
1	Top B "	¾	5⅜	22½
1	Track support C (tapered)	¾	1½-3	22½
1	Backboard D (plywood)	¼	24	32
2	Front pieces E "	¼	4¼	24
2	Front pieces F "	¼	3	23½
2	Rear sidepieces G "	¼	2¼	27
2	Return planes H "	¼	4½	22½
14	Notched runway blocks I	¾	1¼	1¾
6	Runways (sheet or angle iron)	⅛	⅝	21
1	Shot-return chute	⅝	⅝	22½
1	Corrugated-cardboard stop		22¾	30

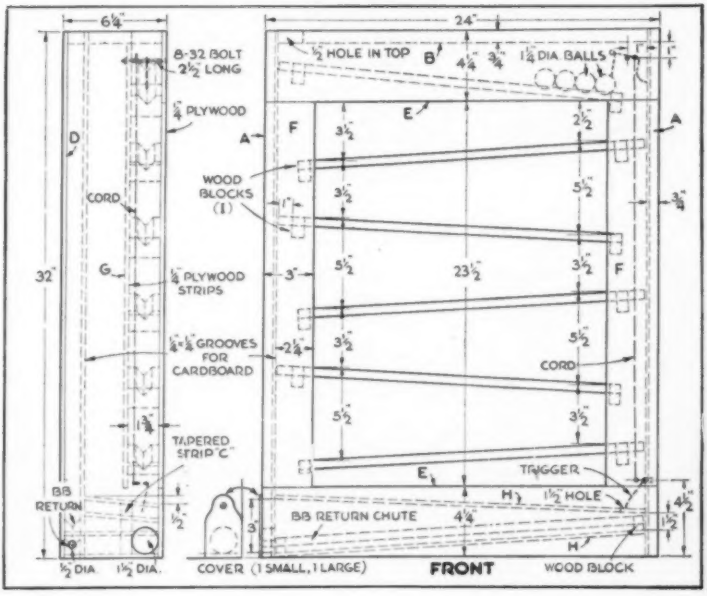
Miscellaneous: Heavy wire, cord, 16 wooden or rubber balls 1¼" in diameter, 1 8-32 bolt 2½" long, ⅛" copper or brass tubing 2" long, glue, and nails.

Note: All dimensions are given in inches and are finished sizes.



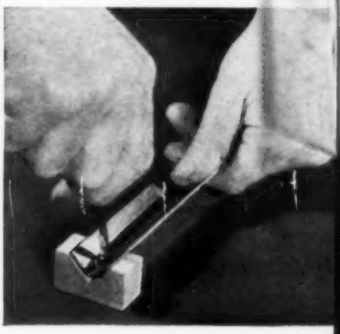


Above, how the target looks from the back when partly assembled. More than a dozen balls can be loaded at once through a hole in the top. They are released one at a time by a trip lever shown at the right above. Nuts weight the lever down until one of the balls strikes a trigger at the bottom, as in the photo at right



Left, the working drawings. Swinging covers over holes in one side are slid away to release spent balls and shot from the return chutes

Below, how the runways are fastened to notched wooden blocks. A similar angle strip forms the shot-return chute



Checking the height setting of a shaper cutter. If the screw does not permit adjustment as high as the work requires, use depth collars on the spindle

Straight Work ON THE Spindle Shaper

By EDWIN M. LOVE

FURNITURE built at home with hand tools usually lacks the moldings that distinguish the products of professional shops. While it is true that the essence of good design is fine structural proportions, suitable ornament does have its place. Beautiful moldings often add grace and delicacy to what would otherwise be a very plain piece of cabinetwork.

Moldings are the special product of the spindle shaper. Its cutters, whirled on a vertical spindle, carve smooth moldings in limitless variety on straight and curved edges. In addition, this machine will joint edges, match them for gluing, cut rabbets, and make intricate corner joints.

How is a shaper set up? The instruction sheet furnished with the machine covers this. When a separate motor is purchased, be sure that it has ball bearings if it is to be mounted with the shaft vertical.

Most light shapers provide for the use of solid cutters having 5/16" and ½" holes. Some spindles are solid with the arbor, having the upper ends stepped for these sizes. Others are double ended and made removable, so that either end can be brought quickly to the top. Again, separate spindles are provided, to be clamped into the arbor with a centering device such as a cone.

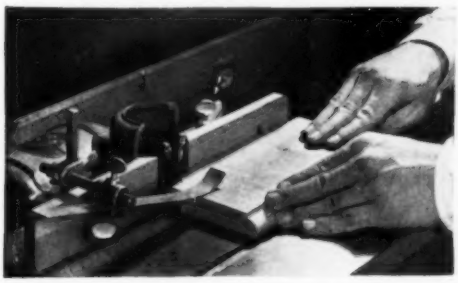
What is the setup for molding straight edges? Slip the cutter over the spindle. If it cannot be raised high enough, put one or more depth collars beneath it, and build up above with others to stiffen the spindle. The cutter wings must incline in the direction of rotation. Clamp the assembly tightly.

Either a straight board notched for the cutter and clamped to the table or the adjustable fence sold by the manufacturer may be used. Before starting the machine see that the cutter clears the fence and that no loose blocks or tools are on the table. Always feed the work against rotation, pressing it firmly against the table as well as the fence. *(Continued on page HW 278)*

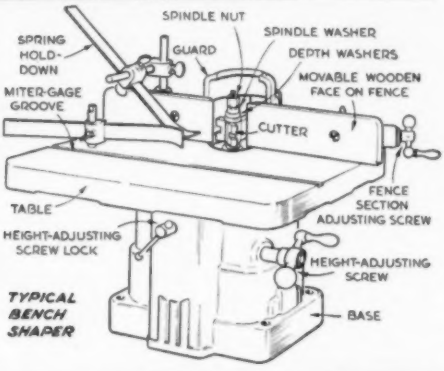
BAND SAW IS ADDED TO JAACKS' SHOP

Robert Jaacks is trying out this new band saw for his model shop. In the photo he is thinning sections of the upper rail of a modernistic cabinet, so that it can be bent around the corners without showing joints.

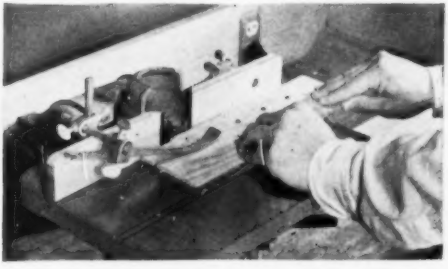
Jaacks' shop now boasts an 8" circular saw, 4" jointer, scroll saw, wood-turning lathe, and drill press, in addition to the new band saw, as well as a good selection of accessories and an excellent collection of hand tools. The model shop is being equipped on a monthly budget of $15.



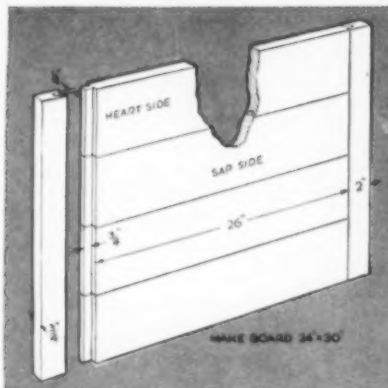
Cutting a rabbet on the upper surface of a board. The hold-down will work from either left or right



Rabbeting the underface. This produces uniform cuts, and the board acts as an extra safety guard



Jointing the edge of plywood. The left section of the fence is advanced to guide the shaped end



Constructing a Drawing Board Is Good Shaper Project

Choose flat, well-seasoned boards of basswood, white pine, or sugar pine. Arrange them edge to edge with heart and sap sides alternately up and the grain running in the same direction. Mark the paired joints and tongue and groove them. Plane flat and square the ends. Cut the deep tongues from the sides after screwing a wide board to the shaper fence for additional support. Cut one side of each end, adjust the machine to make a tongue ¼" thick, and cut the other sides. If your shaper will not groove to a depth of ¾", use the circular saw. Apply glue for 4" at middle of end joints, leaving the rest free to shrink or swell.—E. M. L.

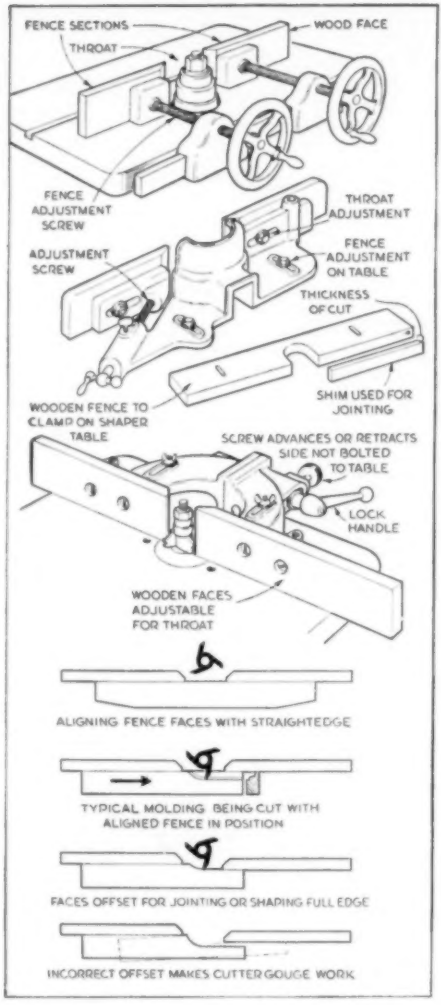
For heavy cuts, time is saved by making two or more passes, or by removing some of the stock with a jointer, as suggested in the drawings. Use all safety devices, and never attempt to pass a small piece of wood over the cutter except with push sticks or jigs.

Should the cut be made on the upper or lower face? For safety, it is better to mold the underface, as the cutter is partly covered by the lumber. Besides, the molding produced is uniform without resetting the cutter, regardless of the thickness of the pieces. However, if the shaper turns only in one direction, there is little choice, for the desired profile, when on the underside, requires that cutting be done from above. With a reversing switch the cutter can be turned over, and the work fed from the opposite side; and if the grain is contrary, the machine can be set to work with, instead of against, the grain.

What is the setup when the entire edge of the work is cut away? Set the offbearing face of the fence—the one beyond the cutter—exactly in line with the depth of cut to be made, and set the infeed side on a line behind it where the full depth of molding will be cut. If the offbearing face projects ever so slightly forward, the end of the molded piece will strike it; if it is behind, the work will rock against it, causing the cutter to gouge and finish with a taper.

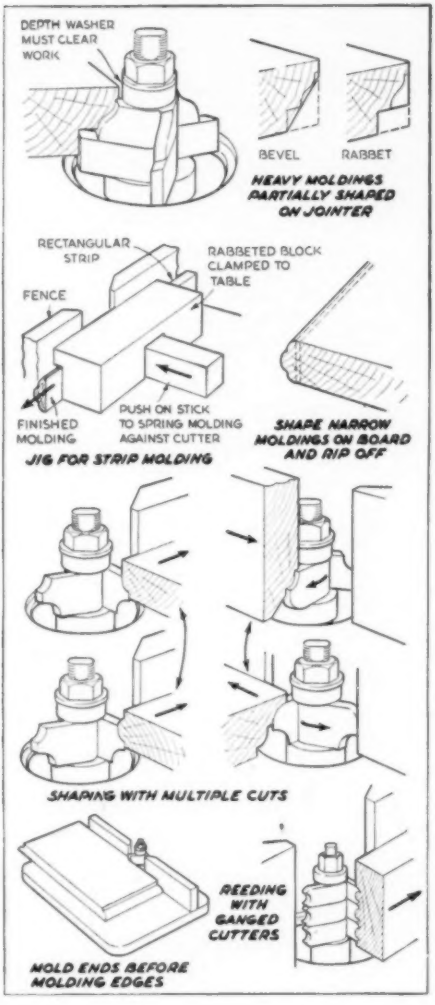
Is a special setup necessary to make narrow, or strip, moldings? Where practicable, shape the edge of a wide board, rip off the molding, joint the edge, and repeat. Narrow strips cannot be held by hand, as they spring and vibrate. A jig, such as that shown in one of the sketches, should be used. It must be clamped rigidly to the table against the fence.

How are tongues and grooves cut for glue joints? Select the pieces as for ordinary gluing, with heart and sap sides alternating


FENCE SECTIONS
WOOD FACE
THROAT
FENCE ADJUSTMENT SCREW
THROAT ADJUSTMENT
FENCE ADJUSTMENT ON TABLE
ADJUSTMENT SCREW
THICKNESS OF CUT
SHIM USED FOR JOINTING
WOODEN FENCE TO CLAMP ON SHAPER TABLE
SCREW ADVANCES OR RETRACTS SIDE NOT BOLTED TO TABLE
LOCK HANDLE
WOODEN FACES ADJUSTABLE FOR THROAT
ALIGNING FENCE FACES WITH STRAIGHTEDGE
TYPICAL MOLDING BEING CUT WITH ALIGNED FENCE IN POSITION
FACES OFFSET FOR JOINTING OR SHAPING FULL EDGE
INCORRECT OFFSET MAKES CUTTER GOUGE WORK

Grooving a piece for a tongue-and-groove joint. The stock is marked with the heart and sap sides alternating, and the fence is set as for jointing

Tonguing the mate to the grooved piece. Test the cuts on waste wood. Run all tongues, or grooves, in succession, holding the face against the table


DEPTH WASHER MUST CLEAR WORK
BEVEL
RABBET
HEAVY MOLDINGS PARTIALLY SHAPED ON JOINTER
RECTANGULAR STRIP
RABBETED BLOCK CLAMPED TO TABLE
FENCE
FINISHED MOLDING
PUSH ON STICK TO SPRING MOLDING AGAINST CUTTER
JIG FOR STRIP MOLDING
SHAPE NARROW MOLDINGS ON BOARD AND RIP OFF
SHAPING WITH MULTIPLE CUTS
REEDING WITH GANGED CUTTERS
MOLD ENDS BEFORE MOLDING EDGES

and the surface grain running in the same direction, and mark the joints to identify pairs. Set the shaper fence as for jointing, but with one of the cutters in place so that the tongue, or groove, is well centered. When the boards are sprung lengthwise, try to force them down against the table; or, if warped, keep the edge being worked flat on the table at the cutter.

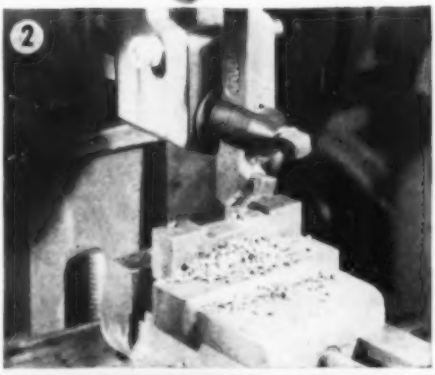
Can end grain be shaped? If the board is wide enough to give good bearing on both faces of the fence, work the end like an edge. Narrow ends can be shaped only in conjunction with a jig. Since the back edge is chipped when the cutter leaves the end, ends should be shaped first, so that the finishing of the edges will cut away the splintered corners.

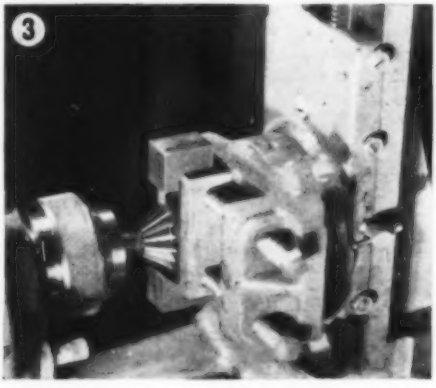
How is variety in moldings obtained with a few cutters? Use a section of one or more cutters, or gang them together; change the depth of one or its position on the work; repeat cuts, or employ a combination of these methods. Another means is to use a tilting table and fence, which give oblique cuts.

MACHINISTS FOR WAR WORK

Thread-Cutting Stop for Lathe

By C. W. WOODSON





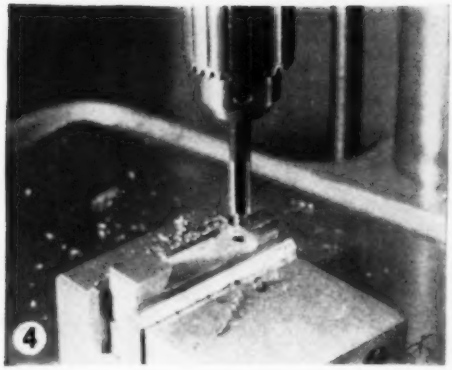
THE task of cutting screw threads in the lathe can be speeded up, and smoother, more accurate work done, with the easily made thread-cutting stop shown in Fig. 1, which is also useful for turning identical diameters. In cutting external threads, the stop is mounted on the cross-slide dovetail, the tool point is set so that it just touches the work, and the adjusting screw on the stop is brought up tight against the cross slide. Then the compound-rest feed is turned in .002" or .003" and the tool is ready for taking the first cut.

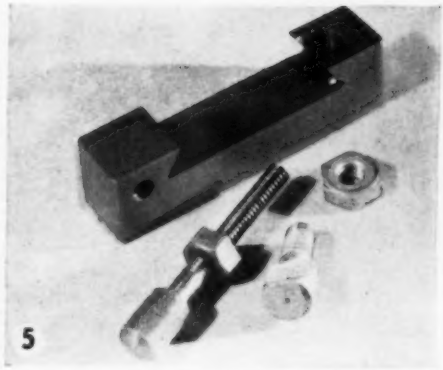
At the end of the cut, you can back the tool off with the cross feed, speedily return to the starting point with the carriage handwheel, bring the cross slide back against the stop, and reset the tool with the compound feed to the depth desired for the next cut.

To make the stop, carefully lay out the dimensions of the cross-slide dovetail on a piece of mild steel and cut the latter to shape. The roughing cuts can be made on a shaper, as in Fig. 2, and the finishing cuts in the milling attachment (Fig. 3).

A 5/16" hole for the locking screw must be drilled at one end as in the drawing. Figure 4 shows this hole being counterbored for the head of the screw. If a ½" counterbore is not available, drill the 5/16" hole and open it out part way with a ½" drill before the dovetail is cut.

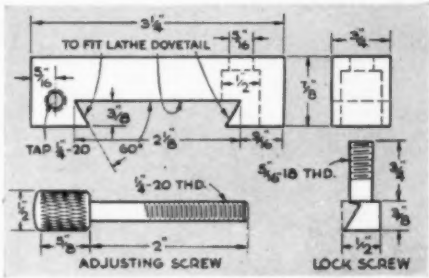
The hole for the adjusting screw is at the





other end of the piece (see the drawing and Fig. 5). Drill it with a No. 7 drill and tap it ¼"-20, then draw-file the piece all over and chamfer the ends, which can be done quickly on an emery disk.

Both the lock screw and the adjusting screw are turned and threaded in the lathe, and the adjusting-screw knob is knurled. Notch the ½" diameter of the locking screw to fit the cross-slide dovetail. Standard nuts are used on both these screws. The parts are shown in Fig. 5 ready for assembly.

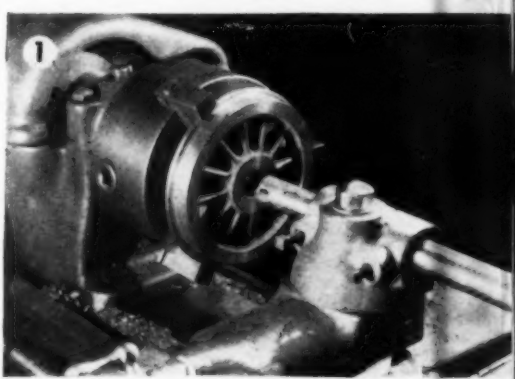


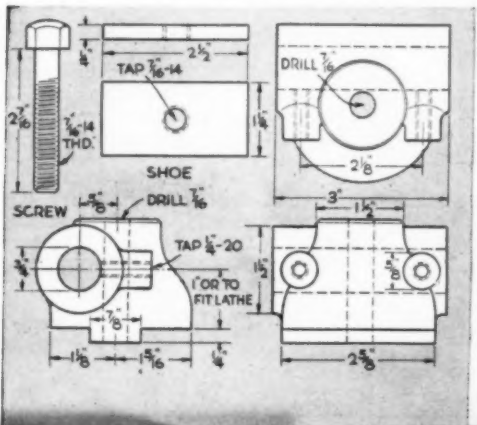
BORING-BAR HOLDER

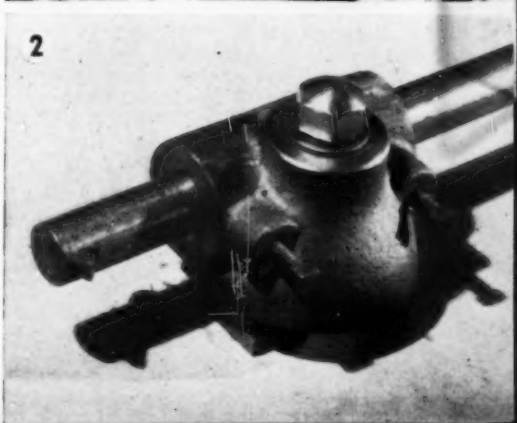
THE chief problem in boring deep holes on the lathe is that of tool rigidity. Because of its long overhang, the tool must be well supported and the largest boring bar possible used. With the holder shown in Figs. 1 and 2, the bar is quickly adjusted to extend just far enough to reach through the work. By the use of split bushings, boring bars of various diameters can be held.

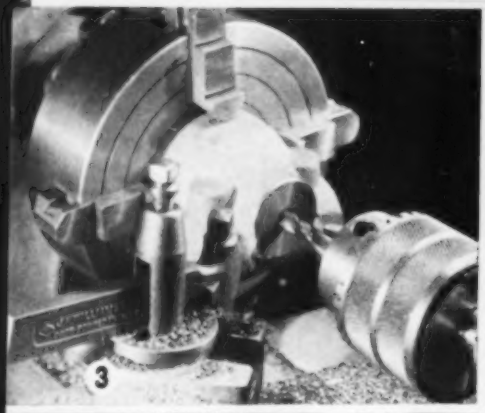
This holder was made from a casting and required a built-up pattern, which was sanded smooth and shellacked. Ample draft is needed to draw the pattern from the sand.

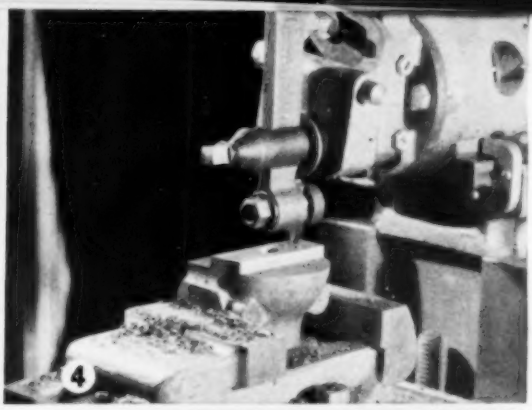
The casting was fixed in the four-jaw chuck as in Fig. 3, the top turned smooth, and the center bolt hole drilled through. Next, the

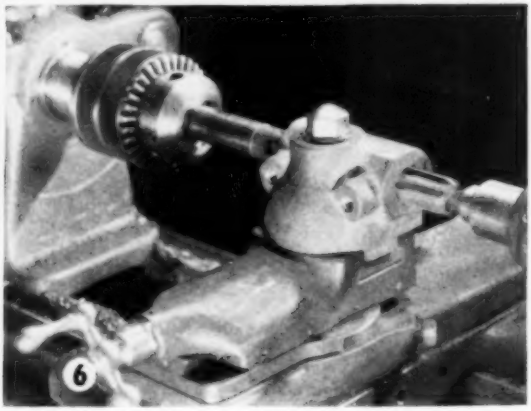












base was machined in the shaper (Fig. 4) to fit the tool-post slot of the lathe. Two No. 7 holes were then drilled as in Fig. 5, and tapped ¼"-20 for hardened setscrews.

A flat steel shoe was made from ¼" stock to fit the slot in the lathe compound rest, and then casehardened. An automobile bolt was cut to length for the clamping screw. With this and the shoe, the holder was mounted on the compound rest so that the hole for the boring bar could be drilled at exact lathe-center height with a drill mounted in the spindle chuck and brought to size with a reamer as shown in Fig. 6.

Boring bars were made up to take boring tips such as can be purchased ready-made. The larger bar is a snug fit in the tool holder; the smaller one is inserted in a split steel bushing that clamps it firmly when the setscrews are tightened.—C.W.W.

How to Remelt Aluminum Chips Without Excessive Waste

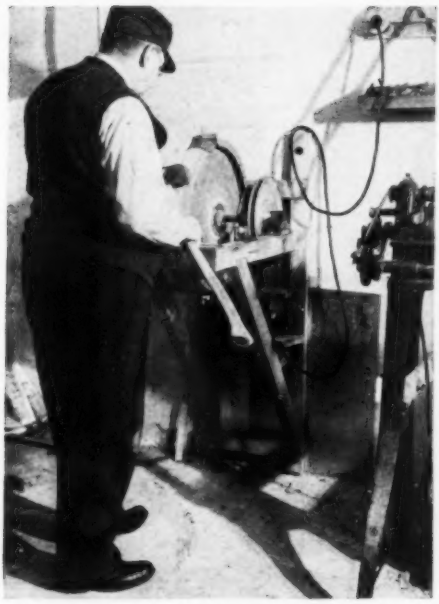
IN A SHOP where small aluminum castings are made and machined, the chips are usually considered waste because they burn if an attempt is made to remelt them. However, if solid aluminum is melted, poured over the chips, and mixed with them thoroughly, the whole mass can be put in the furnace and remelted with little waste.—C. NEMOSECK.

Lead Purified for Casting

WHEN melting lead that is to be cast in molds, add to the crucible a small amount of pulverized carbon. The carbon elements of old dry cells may be saved for this purpose. Any impurities in the lead settle to the bottom of the pot and are left during the pouring. Afterward they can readily be dumped out. The finished castings will be found much smoother if this method is followed.—FRED M. WOLLF.

Countersinking Sheet Metal

WHERE heavy flathead bolts are used on light sheet metal up to No. 12 gauge, there is some objection to using a countersink because it weakens the metal at the bolthead. If the work is comparatively rough, an alternative is to place a large nut under it, slip the bolt through the hole, and strike the bolt a couple of sharp raps with a hammer. This gives a countersunk effect by bending down the edges of the hole.—C. A. CHISHOLM.



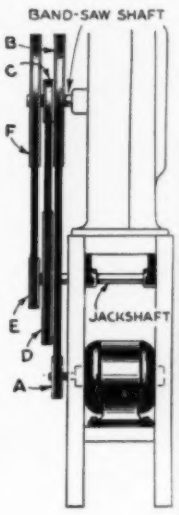
Motorizing an Old Grindstone

OLD-FASHIONED wet grindstones are an efficient shop help when modernized like the one above, which is mounted on a wall shelf deep enough to afford space for a jackshaft. The drive is from a 2″ pulley on the motor to a 12″ one on the jackshaft, then from a 4″ pulley to a 10″ one on the grindstone shaft. A sheet-metal hood surrounding the wheel holds water.—W. F. MESSENGER.

Countershaft Adapts Band Saw for Wood or Metal Cutting

WHERE a band saw is to be used for metal cutting, the single-countershaft setup below not only provides extreme speed reduction without the use of excessively large pulleys, but makes it possible to shift back to high speed for woodworking by removing the outermost belt and inserting a locking screw.

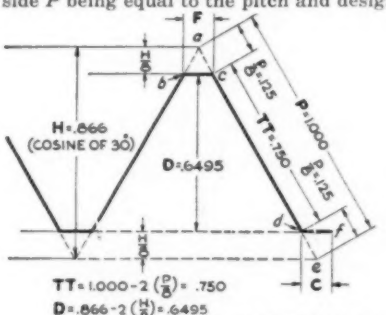
Pulleys *B* and *C* are riveted or bolted together and fitted with a brass bushing on which they spin freely on the band-saw shaft. Pulleys *D* and *E* are both locked on the countershaft. Pulley *F* is locked on the band-saw shaft. Drill a No. 7 hole through it near the hub and into pulley *C*. Tap for a ¼″-20 bolt, remove all burrs from the pulley surfaces, and open the hole in *F* to clearance size.



Pulley sizes for any required speed can be calculated as follows: Multiply the size of the driving pulley by its speed, and divide the product by the desired speed of the driven shaft. The answer will be the diameter of the required driven pulley.

TOOL TRAVEL IN THREAD CUTTING [*LATHE WORK*]

The travel of a tool in cutting threads may be calculated by reference to the accompanying diagram. A threading tool fed at 30 deg. to the work must travel along the line *TT*. All 60-deg. threads are based upon an equilateral triangle, the side *P* being equal to the pitch and designated as unity. Flats *F* and *C* at the top and bottom of the thread respectively are each one eighth of the pitch. The sides *a-c* and *d-e* of the equilateral triangles *abc* and *def* are therefore also each one eighth of the pitch, or .125. Consequently *TT* must be 1.000 minus .250, or .750.



To find the tool travel for any given thread, it is necessary only to divide .750 by the number of threads per inch. Thus, for 10 threads per inch *TT* is .075″; for 9 threads, .0833″.

However, if the tool is fed in at 90 deg. to the work, the tool travel is equal to *D*, the actual height of the thread, found by dividing .6495 by the number of threads per inch.

POPULAR SCIENCE MONTHLY SHOP DATA

Soldier Sailor and Marine

JIGSAWED LAWN FIGURES OF MEN WE ADMIRE IN OUR ARMED FORCES

By Juan Oliver

APPROPRIATE to the American home are these up-to-the-minute lawn ornaments, a standing salute to our armed forces. They were designed to represent faithfully the marine dress uniform, the navy undress uniform, and the army service uniform.

Waterproof plywood ½" thick is the best material, but ordinary plywood or even plain wood will serve if properly finished. The patterns may be drawn on stock ruled off in 1" squares, but for more than one of each figure, use heavy paper and transfer with carbon paper. Follow the lines on the 1" squares as they appear on the squares at the right.

To prevent splintering with the jig saw, back the plywood with heavy cardboard or thin waste wood. Sandpaper the edges carefully. Drill a ¼" hole 1½" deep into the bottom edge of each figure for a 12" length of dowel to be pushed into the ground.

Apply a suitable undercoat and paint or enamel. Sunfast outdoor finishes are good. If paint is used, an overall coat of outdoor spar varnish will make it durable.

The soldier's uniform, shirt, and tie are olive drab; buttons and belt buckle gilt, and belt, visor, and shoes leather brown. Shade olive drab with a little black to indicate pockets and trouser creases.

The sailor's uniform is white, his tie and shoes black, and shoulder stripe blue.

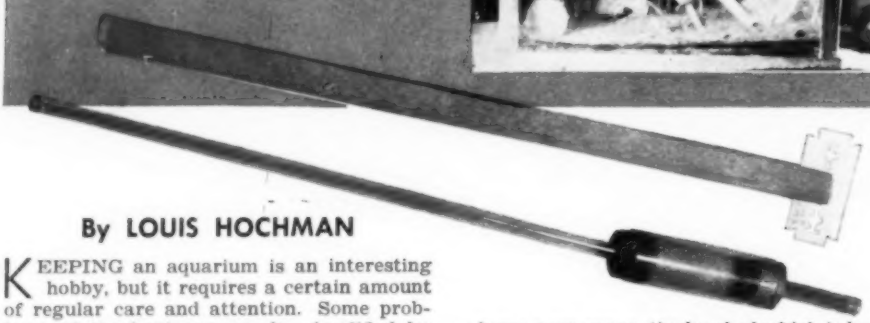
Most colorful is the marine, with rich-blue trousers, navy-blue coat, and gilt buttons and belt buckle. Trouser edges are crimson to represent stripes; belt and cap white; shoes, cap band, and visor black; and chevrons and service stripes gold on a red field.

Paint faces and all hands except the marine's flesh; his are gloved and are white.

1"SQUARES

Aquarium Tips

Dirt can be sucked from an aquarium by a simple pumplike device, as at right. This is made from tubes, a vial with an open bottom, and holed stoppers (shown below in the close-up). The razor blade on the stick is for scraping off algae



By LOUIS HOCHMAN

KEEPING an aquarium is an interesting hobby, but it requires a certain amount of regular care and attention. Some problems of the beginner can be simplified by using the methods illustrated.

After cleaning out a fish tank, the nuisance of carrying bottles of water back and forth to fill it can be avoided by filling a large pot with water, setting it on the edge of the aquarium, or alongside on a suitably raised platform, and siphoning the water through a narrow rubber tube. A spring-type wooden clothespin clipped to the handle of the pot will hold the tube in position. The water flows gently without disturbing the contents of the aquarium.

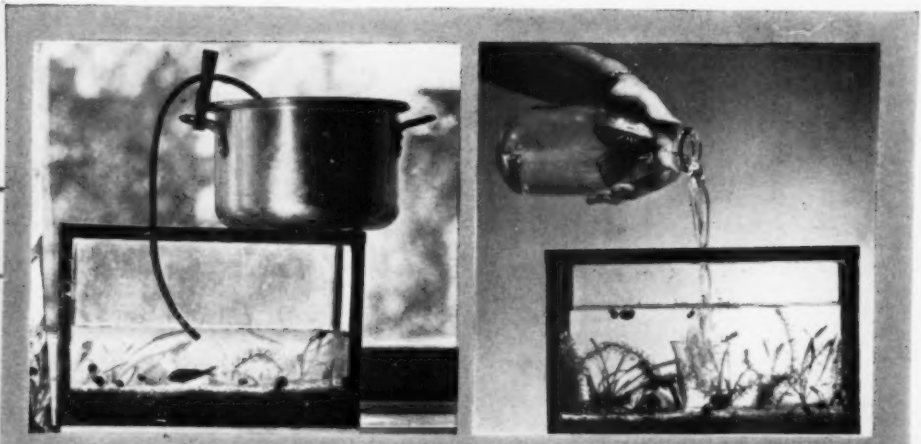
Another way to add water when the level has dropped through evaporation is to set a small glass tumbler in the bottom of the tank and pour the water directly into it. The mouth of the glass should be below the water level before the water is poured. Water can be poured in rapidly, yet the contents of the tank will not be disturbed.

Still another convenient water deflector is a large soup spoon, the bowl of which is bent in at right angles to the neck, and the handle bent to fit over the rim of the tank. When hooked in place, the spoon gently deflects the water that is poured into it.

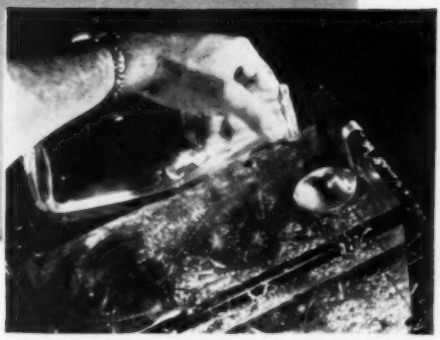
Tropical fish fanciers, who would like to keep two kinds of fish that are normally opposed to each other in the same aquarium, can do so by setting a glass partition into the tank. The partition is invisible under water. It will also serve to separate the young from their parents, when necessary, to prevent the parent fish from killing them.

Setting plants into the gravel of a filled aquarium is a messy job if attempted by hand, but when it is done with a planter, consisting of a wire rod bent into a small triangle at the bottom, there's nothing to it.

The base of the triangle is used to push the roots of the plants deep into the gravel, and also serves to smooth over the surface of the gravel. If desired, the other end can



Three methods of filling a tank or renewing water lowered by evaporation. At left above, the large pot and siphon, consisting of a rubber tube held in place by a clothespin, will save many steps in filling a large aquarium after it has been given a periodic cleaning. Above right, a tumbler sunk below the surface level will permit rapid pouring without disturbing the tank's contents, while the spoon bent to hook over the rim, as shown just to the right, will also prove an adequate deflector



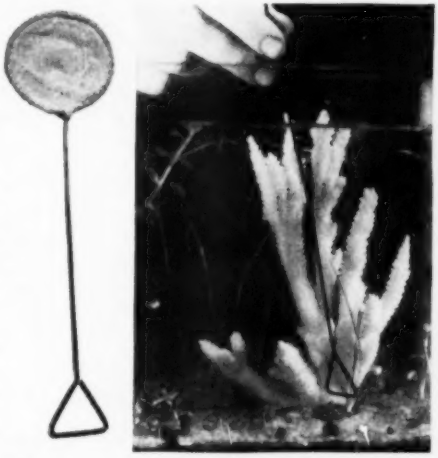
be made into a fish net by bending it into a loop and sewing on a piece of any available fine material, such as from a silk stocking or net curtain.

An algae scraper can be put together in a jiffy without bolts or screws by merely forcing an old safety-razor blade into the end of a slat of soft wood. The blade will cut its way into the wood, which will hold it in a firm grip and permit the sides of the aquarium tank to be cleaned.

Dirt that collects in the bottom of the tank can be sucked out with a pumplike glass device made by cutting the bottom out of a small glass vial and fitting both ends with one-holed rubber stoppers. Into one of these stoppers insert a 1½" length of glass tube, and into the other, a much longer length of the same tubing.

To use the device, keep your thumb pressed over the end of the longer tube, and sink the vial end until it is directly over the dirt to be removed. Then release the thumb until the dirt has been drawn into the vial. Now replace the thumb, lift out the gadget, and allow the dirt to flow out into a receptacle by removing the thumb once more from the end of the tube.

These few aids will prove great time-savers for the fish fancier.



Setting aquatic plants in a filled tank is made easy, as shown above, by using a wire rod bent into a triangle at one end. This also serves for smoothing gravel on the floor. The other end can be looped and fitted with a light fabric fish net

High-Lighting Machines

TWO-TONE PAINT FINISH REDUCES FATIGUE AND

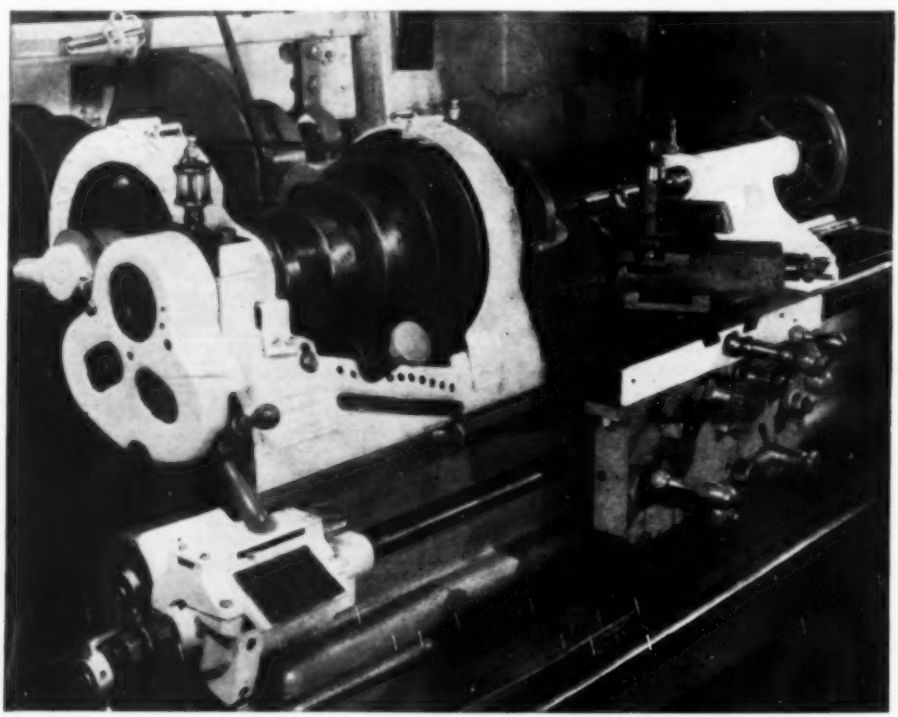
By Walter E. Burton

ONCE I knocked a sizable triangle of skin off my knuckle by getting too chummy with a whirling lathe dog. Then I nicked a piece out of the lathe carriage by running it too close to the same dog. But I don't think that dog is going to bite so much in the future, for I have muzzled it with a coat of paint. The accidents, I discovered, happened because I couldn't see the dog plainly enough. Now, as it whirls, it appears as a light buff-colored disk, and is so conspicuous that I keep well out of its range as a matter of course.

This was only the beginning. I also painted the lathe headstock, the guards around the back gears, the area around the threading chart, the tailstock, and the front of the carriage along the top—all the same light buff. The remaining parts I painted medium gray. As a result, the lathe is a better machine—safer, more accurate, easier and less fatiguing to use. Painting it made such a difference that I applied the brush elsewhere in the shop.

This idea of painting shop machines in two colors is one of the most surprising contributions of research to industrial production. It represents several years of study by color specialists of E. I. du Pont de Nemours and lighting engineers of the Philadelphia Electric Company.

Some years ago a shoe manufacturer whose employees complained of headaches and eyestrain decided that the trouble might arise from sewing black shoes on black machines. He told one of the workers to repaint his machine with some bright color. The man did so, and soon other employees



This lathe is "spotlighted" with buff and gray paint to make its important parts easier to see and the machine safer to use. Note that the dog is buff. The tailstock wheel might also be light to advantage

with COLOR

PREVENTS ACCIDENTS

began to clamor for paint and brushes so they could do the same thing. In a short time the factory looked like a circus paint shop, but production went up, the accident rate fell 70 percent, and headache and eyestrain complaints ceased.

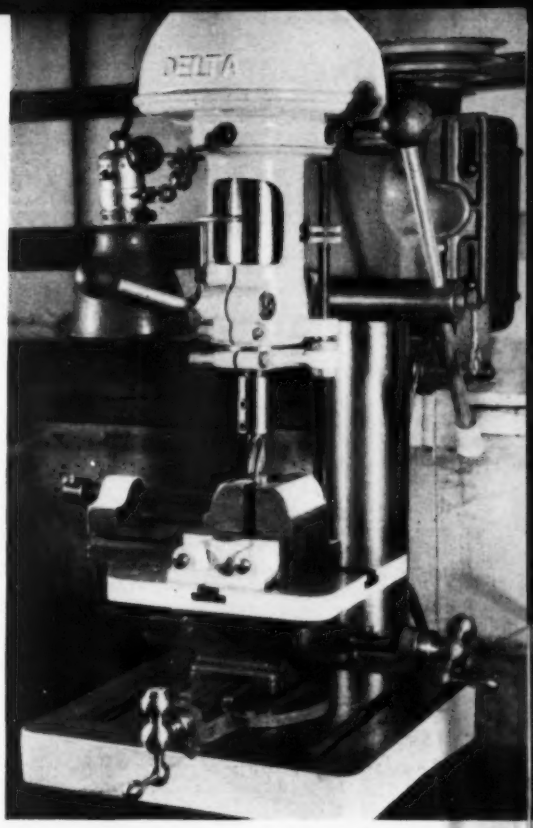
In a more scientific way, research experts at du Pont have worked out a painting scheme of surprising simplicity and effectiveness—a scheme that is adaptable to both the home workshop and the mass-production bomber plant. In one test, they repainted a punch press and a metal shear in the repair shop of the Philadelphia Electric Company every other Friday. For two weeks the machines were light blue, for another two weeks, aluminum, and so on through yellow, light green, buff, light gray, and medium gray. The light-reflecting power of each color was measured. Time studies were made on routine tasks. Mercury and incandescent light sources were compared, accident frequency noted, and the operators' opinions and reactions recorded.

As a result of these and other studies, it has been found that the most effective way of painting a shop machine is to make it light buff around the working area and medium gray on remaining areas. The paint should dry to a satiny, nonglare finish, and should be of an oil-resistant and washable type.

On first seeing a lathe, milling machine, or other tool painted in the buff-and-gray combination, one is instantly struck by its handsome appearance. But the value of such a color scheme goes beyond mere beauty. The buff color "spotlights" the work by reflecting more light on it and on the tools, and by making control handles and knobs, dials, scales, tools and other important parts stand out in better contrast.

The use of buff and gray together makes the machine easier to keep clean than if it were all buff. Also, the darker background color causes the buff areas to stand out, contributing to the spotlighting effect. The colors are such that the eye moves from one to the other without experiencing an abrupt change of brightness. Finally, the spotlighting effect draws attention to danger areas, thus reducing accidents, and this color combination makes the work stand out with a positive, three-dimensional quality against the machine itself.

The du Pont-Philadelphia investigators went a step further. They studied the effect



Drill press, milling table, and vise are finished here in the buff-and-gray color scheme. Usually important parts are made light, others dark for a background, and machined surfaces left unpainted

Tools with handles painted distinctive colors are easy to identify and can be found quickly when dropped amidst shavings or other refuse in a shop

Originally a uniform, dark gray, the grinder above blends with its background, and working surfaces are hard to light. But note the difference with new paint as shown in the photo below

Here buff is used to refinish surfaces around exposed parts of the wheels and medium gray for the remainder so that the work areas are high-lighted both by contrast and by reflected light

of various colors of paint on shop walls and ceilings. No combination as definite as that for shop machines was worked out, but the findings can be summarized: Paint ceilings a color that reflects 75 percent or more of the light striking them. Walls directly in line with a workman's eyes should have a reflection factor of 50 or 60 percent. When factory ceilings are excessively high, a gloss white may be the best solution, particularly if such factors as dirt resistance and washability must be considered. For low ceilings, a flat or eggshell finish is recommended. White reflects most light, but may not be as restful to the eyes as a light color.

I liked the lathe paint scheme so well that I applied it to a bench grinder, drill presses, and other shop equipment. In each case, the improvement was immediate and pronounced. When production machinery such as a turret lathe is painted in the buff-and-gray combination, improvements to be expected include faster output, reduction of errors, quicker detection of flaws and fewer accidents.

Even in a shop where the tools are used only occasionally, such as the average home workshop, there is almost as great a change. Immediately the shop owner discovers that it is more fun to work at his machines, and that longer hours can be spent at them without excessive eye fatigue. Another important effect is the emphasizing of danger areas by improved contrast and concentration of light. This does not mean, however, that conventional guards and other safety precautions should be ignored.

The exact manner of painting machine tools to produce a "spotlight effect" will vary with each one. Here is how a few typical units were treated:

Bench grinder: Buff was used on the ends of the motor, the surface and exposed edges of the guard plates over the wheels, the edges of the guards adjacent to exposed portions of the wheels, and the edges of the grinding rests. Medium gray was used for all other surfaces.

Drill press: Buff on the underside of the head, to improve downward light reflection, also on the edge of the table, the front and sides of the housing inclosing the quill and spindle, and the pulley guard. All other painted surfaces were medium gray.

Milling table for drill press: Buff on the edges of the slotted table and the unmachined sides of the table jaws.

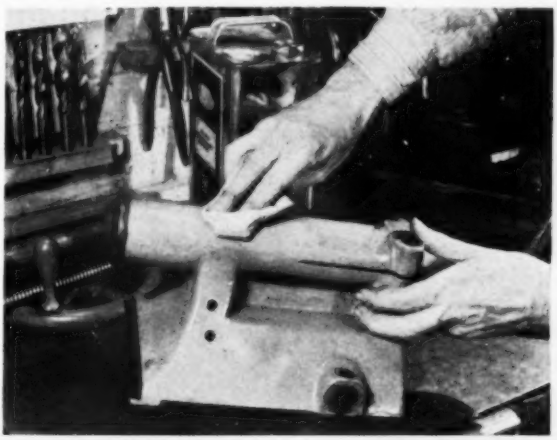
Drill-press vise: Buff on the unmachined sides of the jaws and other parts. Machined surfaces should be left as they are.

The full magic of color combinations cannot be utilized without proper lighting. A high level of general illumination, with the light well diffused, coupled with localized illumination on the work areas, is essential. Fluorescent lighting is particularly effective.

Paint can also be used on hand tools to advantage. A plan that cuts tool losses consists of finishing the handles or other easily seen areas a bright, eye-catching color. If a tool so painted is dropped, it is easy to find. You'll be surprised to discover how much easier it is to locate a red-handled chisel among pine shavings than one having a natural wood finish!

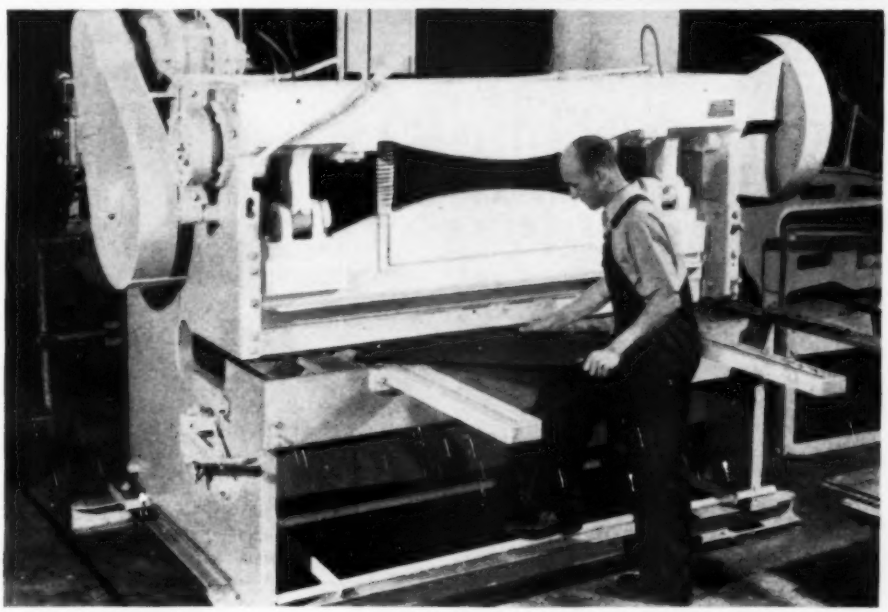
It is a good idea to use a different color for each class of tools, and to select colors that contrast with normal surroundings. Thus screw drivers might all have amber-colored handles; wood chisels, light red or blue; metal-working chisels, buff; nail sets, blue; and so on. If a universal scheme of painting hand tools were worked out and put into practice, untold man-hours might be saved by making it easier for workmen to spot desired tools among others, or to find dropped tools.

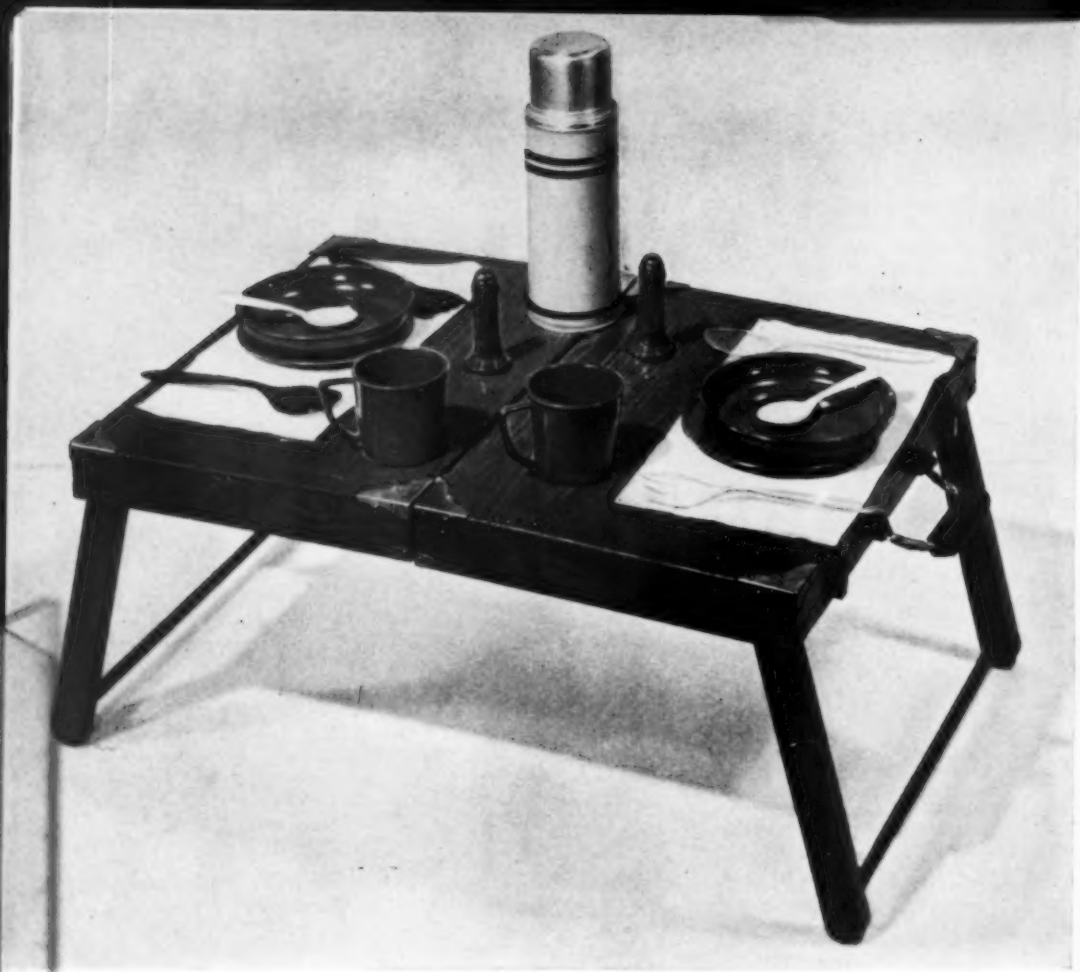
Before painting any metal surface, make sure it is clean and free of grease. Remove all the old paint if convenient, or sand it smooth. Apply whatever primer the finishing material may require. When using lacquers, remember that some lacquer solvents will loosen old oil paint or enamel.



Before repainting, remove the old finish if convenient, or clean it with either gasoline or kerosene and wipe off the greasy film with a cloth moistened with a lacquer thinner or liquid, waxless paint remover. Irregularities are then sanded down and the paint applied

Scientifically chosen colors on the shear below lessen eyestrain and nerve fatigue and have a good psychological effect. Note how the metal being cut stands out in contrast to the danger area, thus reducing the hazard of personal injury and errors in workmanship





Working Time: Two Evenings

NOVEL MATERIAL-SAVING PROJECTS DESIGNED FOR POPULAR SCIENCE BY ERNEST R. DEWALT

PICNIC KIT. This portable luncheon case, which when closed is only 4″ by 12″ by 18″, can be readily converted into a picnic table to keep the food off the ground, or above the ever-present sand, should the picnickers find themselves at the beach. Opened up, the table is 18″ by 24″, and 11½″ high.

The case is made up as one piece from ⅜″ by 4⅛″ fir plywood. If a circular saw is available, use end dado joints, and butt-joint the top and bottom lids on the frame. Saw the box apart against the fence of the circular saw, making two similar lids 2″ high. This will insure a well-fitted case when the two parts are attached with a pair of hinges and secured with snap catches, split-riveted to the covers. Glue mitered triangular-strip fillets all around the inside for strength and easy cleaning.

The legs are four similar pine pieces, ¾″ by 1¼″ by 11″, rounded at the ends. The notches act as stops for the legs when these are open. Holes are drilled 1″ on center from the bottom of the rounded ends for the ½″ dowel rails. Drill 5/32″ holes in the notched ends for 1¼″ oval-headed trunk rivets.

The ½″ dowel rail is cut to the inside box dimension less 3/64″ clearance on both sides for ½″ washers. Glue the dowels into the holes and pin with 1″ nails, keeping both legs lined up on a flat board. Drill 5/32″ holes

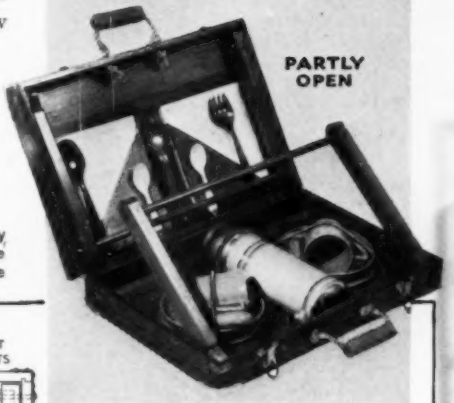
in the sides of the box for the leg rivets. Make certain that the turning is free from the top nside walls. Rivet the legs in place, using one ½" washer between each leg and the case and another ½" washer on the outside of the case.

Apply eight stock brass metal corners as shown to prevent breaking. Cut eight elbow corners from scrap brass and nail to the other eight corners with escutcheon pins. Drill four ⅜" holes, centered on the tops of both lids and spaced as indicated, for the ¼" Manila-rope handles. These are knotted outside of the holes after they are strung through the flattened 1" dowel handles, and then knotted inside. Both handles extend 1¾" away from the box.

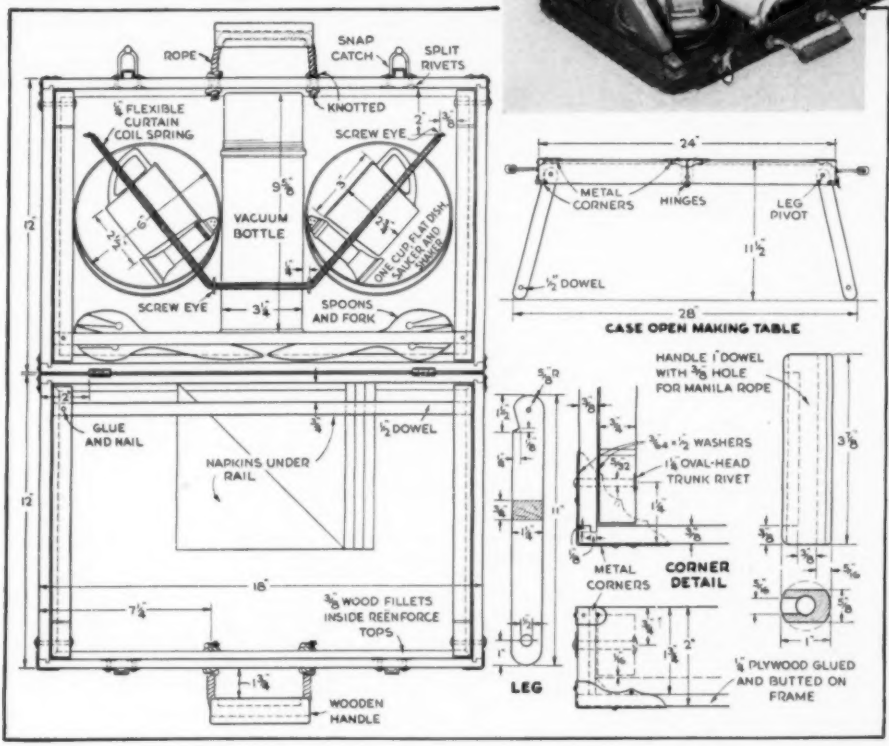
The dowel stretchers and one length of ¼" curtain coil spring stretched through screw eyes secure the contents of the case.

Four small rubber-headed tacks are driven into the bottom of the box to keep it from marring any surface on which it is placed.

For an attractive, durable finish, stain inside and out with thin white paint, tinted with Prussian blue oil color, and wipe even-



Packing and serving picnic lunches is made easier by the use of this kit. The details of its construction are shown below. It is built chiefly of plywood and pine



ly. Varnish with two coats inside and three coats outside. Sandpaper lightly between coats. The final coat may be waxed several times. The wooden handles are finished with two coats of vermilion brushing lacquer or enamel. Working time: 6 hours, exclusive of painting.

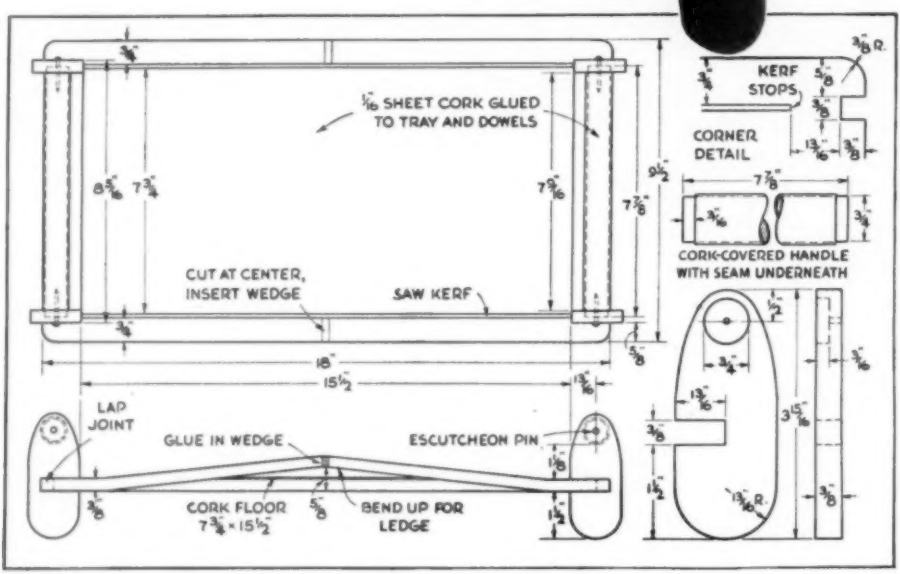
TRAY WITH BENT RAILS. The craftsman will find this tray of special interest because of its novel construction and the economy of material. The side ledges keep dishes from slipping off, and the sheet cork on the tray floor not only prevents glasses from sliding around, but also lends color to the tray itself.

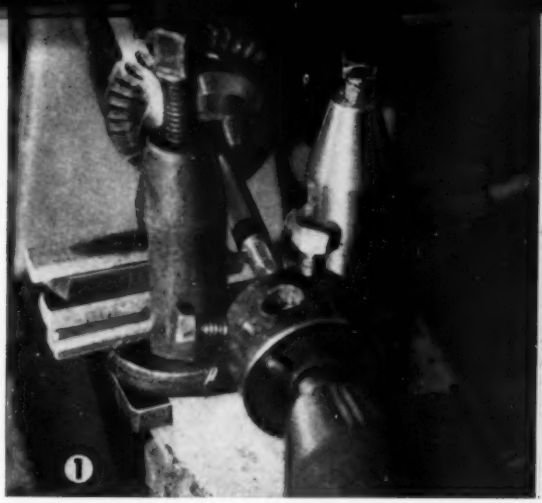
The floor is of ⅜" fir plywood, 9½" by 18". Cut two parallel kerfs by bringing the sheet down on the raised circular saw ¾" from the rip fence. Stop this cut 1 3/16" in from the opposite ends, and open up with a right-angle cut at the dead center of the ¾" wall. Insert a wedge to bend the strips up.

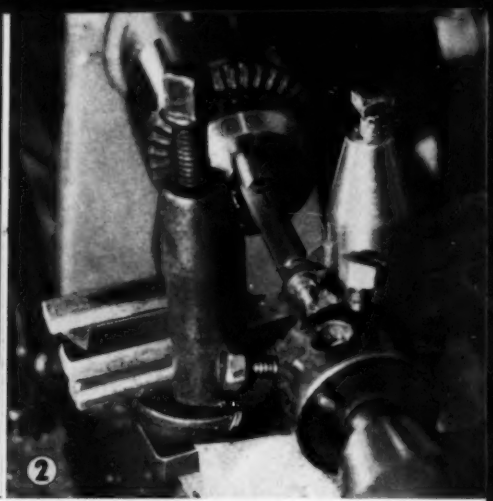
Four legs raise the tray 1⅞" from the table line, giving sufficient height for bed service in the sick room. These legs are cut from ⅜" by 1⅝" by 3 15/16" plywood and have rounded top and corners and a ⅜" by 13/16" joint for lapping over on the notches of the floor. The ¾" holes, 3/16" deep, are for the maple dowel handles. These are 7⅞" long. Assemble the tray by inserting the dowels into the side holes. Next, lap the legs on the tray and glue them in place after a trial fitting. Secure the handles by spots of glue and ¾" escutcheon pins. Attach with rubber cement a 1/16" by 7¾" by 15½" sheet of cork, if available, to the tray floor, and cover the handles similarly.

The tray may be finished like the picnic box, or in any way preferred. Do not, however, use stain on the cork. Varnish twice, and wax. Working time: 4 hours.

Here is a tray with unique side rails bent up from the plywood piece that makes its floor. The legs are just high enough for sick-bed use





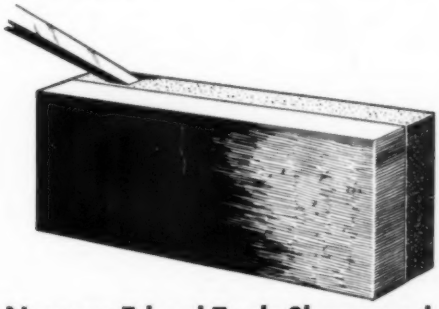


Twin Tool Posts Speed Production of Small Screws on Lathe

HAVING several hundred shouldered screws to turn out on my lathe, I found the work could be speeded up by the use of two tool posts in the slot of the compound rest. The extra tool post was made in the shop. I turned the compound rest with the slot almost at right angles to the spindle, so that one tool post was in front of the work and the other behind. In the first I fixed an ordinary turning tool. In the rear post a cutting-off tool was mounted upside down. Blocks were used instead of tool holders, as shown above.

The stock was first knurled all over, and then fed through the spindle. Figure 1 shows how the first diameter was turned. The smaller thread diameter was formed with the same tool, and the threads were run on with a die held in the tailstock. Finally the cross slide was brought forward, as shown in Fig. 2, so that the rear tool cut off the screw.

By adjusting the angle of the tool-post slot, I was able to offset the two tools just enough to cut the heads off automatically to correct length.—WARREN I. FILLMORE.

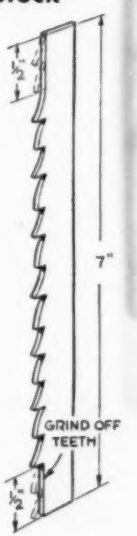


Narrow-Edged Tools Sharpened on Side of Oilstone

MANY a good sharpening stone has been ruined by using its wide faces for whetting small tools. This eventually cuts grooves into these surfaces, which are then useless for sharpening wider tools. To avoid spoiling a stone in this way, set it on edge and sharpen narrow tools on a side surface, as shown above. If it is a double-face stone, time is saved because it need not be turned over in changing from the coarse to the fine face.—C. E. LIMBERG.

Wide Blade Used in Jig Saw for Cutting Thick Stock

SOME heavy-duty scroll saws will cut stock as thick as 4½" if a 7" fragment of band-saw blade is used in place of an ordinary jig-saw blade. Grind off the teeth for ½" from each end as shown at the right. Clamp the blade in the V-notch of the lower chuck, and in the usual manner in the upper chuck. If it is too thick, grind it thinner at the ends. Blades up to ½" wide can be used. The saw should run at 1,750 r.p.m., and stock 3½" thick or less can be cut with the spring hold-down in place. For cutting heavier material, the hold-down must be removed. Be sure to use a section of band-saw blade that has not previously been softened by brazing.—CARL W. BERTSCH.



Miniature Models

CRAFTSMEN SHOW SKILL IN MAKING TINY TOOLS

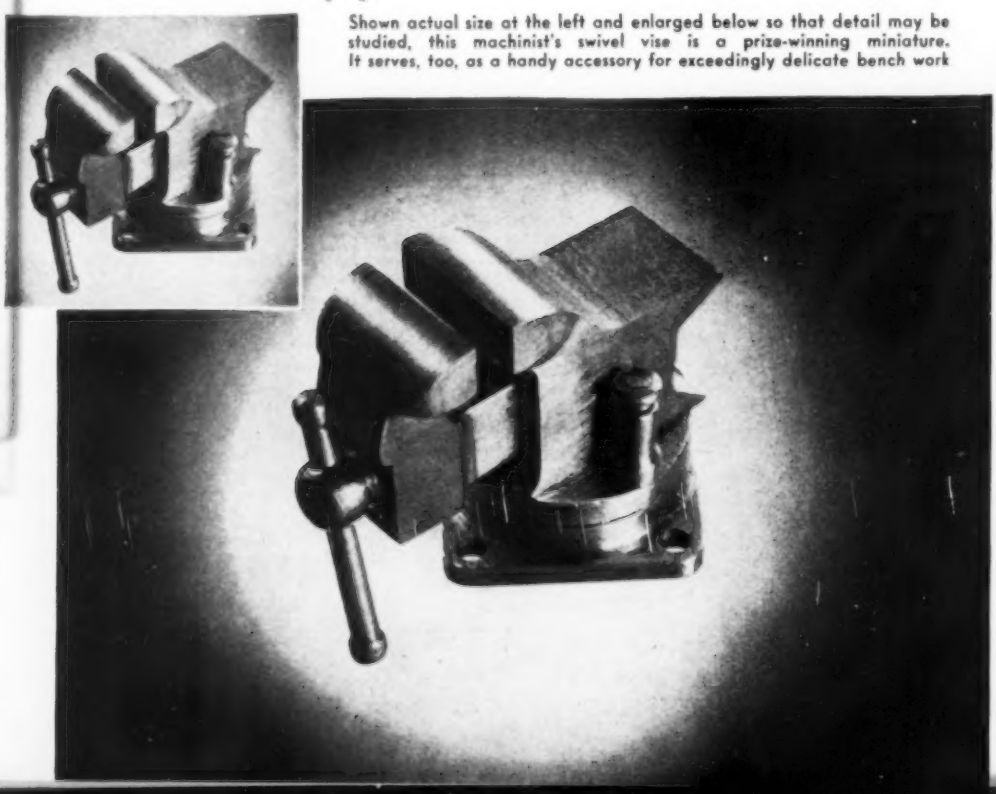
MINIATURES of any kind have a fascination all their own. Making tiny mechanical reproductions often calls into play the utmost skill, patience, and ingenuity of a good craftsman, but anybody who likes to work with tools can build miniatures of some kind.

A recent contest conducted by POPULAR SCIENCE brought forth a variety of entries, including Lilliputian engines, glassware, vehicles, ornaments, anchors, and many other things, but, as might have been expected, miniature tools predominated. Tiny micrometers, planes, jacks, vises, hammers, pliers, and other tools were submitted. The prize-winning ones are shown full size in the photographs on this and the two following pages, along with enlargements that permit the inspection of detail.

SWIVEL VISE. Here's an intriguing job—and a handy bench accessory for anyone who does delicate work. Wassil Olevia, of Palmerton, Pa., won an award for this model, the parts of which are shown full size in the accompanying drawing. Most of them can be sawed and filed to shape from cold-rolled steel, but the base, screw, locking pin, and stud are best turned in a lathe. Insert the vise screw in the sliding jaw, press on the knob, and drill through both parts simultaneously for the handle. The vise nut must be a free fit in the slot of the jaw; it is held in the body with a 4-40 screw, which provides a simple means of adjusting it to the right height. Mount the body on the base with the pivot screw, then swing it to the three locking positions, using the hole in the edge of the body to spot the holes in the base.

PLANE. If your trade or hobby is woodworking, you might rightfully wear a miniature smooth plane on your watch fob. Frank T. Freeman, of Ada, Okla., constructed the plane, which actually takes off a respectable shaving. Both the knob and the handle are attached with screw studs. The blade is slotted for adjustment and well supported. Thumb planes of this size often prove useful in shaping small boat hulls and the like.

BEAR TRAP. One who knows traps will appreciate the model on the facing page. Open the



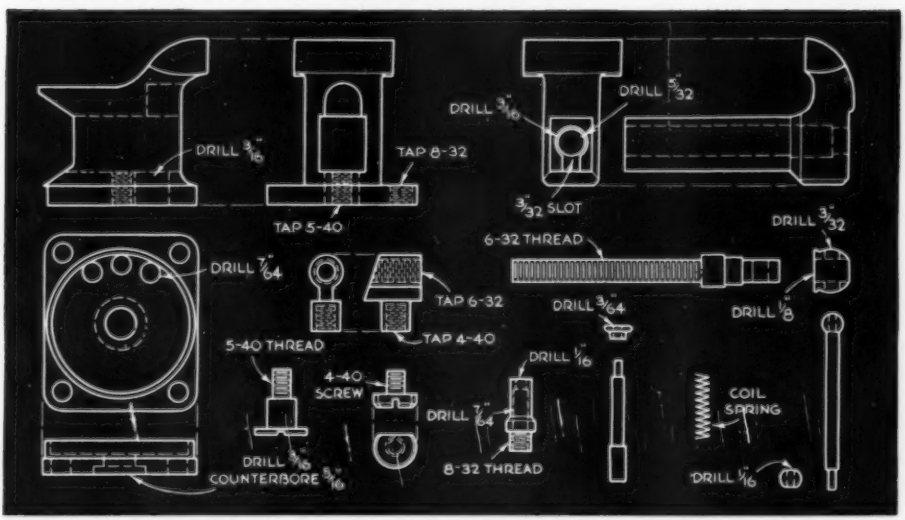
Shown actual size at the left and enlarged below so that detail may be studied, this machinist's swivel vise is a prize-winning miniature. It serves, too, as a handy accessory for exceedingly delicate bench work

jaws, set the target and catch as shown in the photograph, and this tiny trap is "loaded for bear"—strictly scale size, of course. The jaws snap shut when the target is touched with a matchstick. Complete with chain and ring, this fascinating model is the work of Melvin Koch, of Lititz, Pa., for whom it won honorable mention. If fitted with a wire spring catch, it would make a unique necktie clip. Rivets join the parts together, and the finished trap is attractively nickel plated.

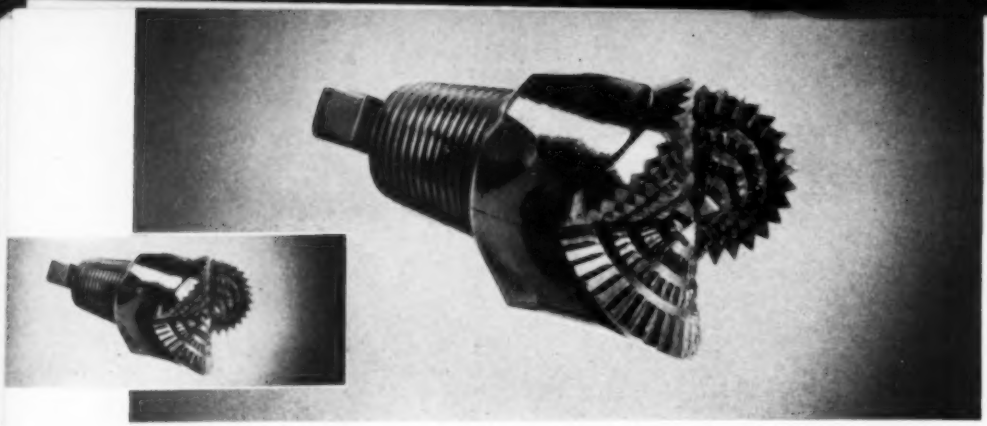
ROCK BIT. Most unusual is the one-tenth scale model of a rotary rock bit that won a prize for John H. Martin, of Houston, Tex. The three cone-shaped cutters revolve independently. This type of bit is used for drilling oil and gas wells through rock and other hard formations. The model was made of brass on a 10" lathe with the help of special jigs and fixtures. Dental burrs were used for most of the milling cuts. All the parts are heavily nickel

This little watch-fob plane, shown enlarged above and actual size at right, can be used for shaping very small parts for wooden models

At right is an actual-size photo of a sturdy bear trap. Its jaws spring shut with a vicious snap

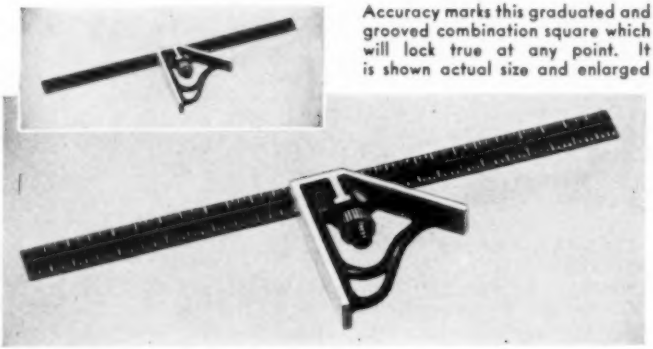


Detailed drawings in full size of the parts needed in making the miniature vise on the facing page. Some may be sawed and filed to shape, but the base, screw, locking pin, and stud should be turned



Dental burrs made most of the milling cuts in this model of a rotary rock bit used in drilling for oil. Special jigs and fixtures helped in turning. One photograph is full size, the other, enlarged

plated, and a slot is provided for a watch-fob strap.



Accuracy marks this graduated and grooved combination square which will lock true at any point. It is shown actual size and enlarged

COMBINATION SQUARE. Although he worked to a very small scale, Victor Roming, of Carmel, N. Y., succeeded in showing much intricate detail on this tiny model that won a prize for him. The blade is graduated and is grooved its full length. A clamping screw that engages the groove locks the head at any point on the blade. The head itself, only ⅝" long, is an exact replica of its prototype, and is accurately slotted so that the blade locks true wherever it may be clamped. Such a square also might be worn on a watch fob as evidence of the wearer's interest in craftwork of some kind or other.

DYEING LEATHER [*LEATHER CRAFT*]

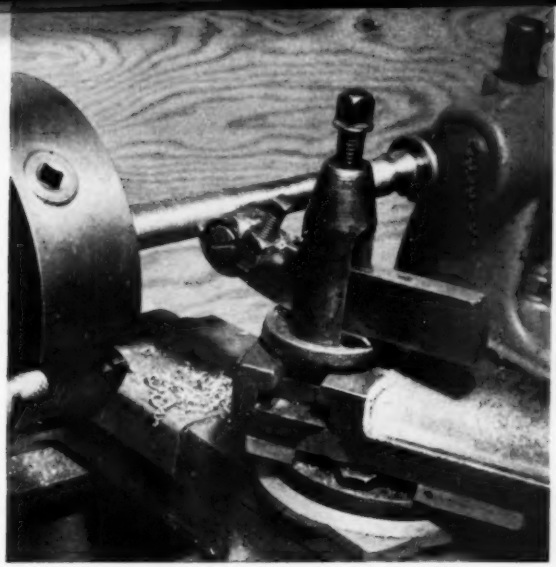
Dyes for leather may be water stains, oil stains, acids and oxides, spirit stains, and waterproof drawing inks. The amateur must be very careful if acids and oxides are used since they will burn the leather and cause it to crack if used in too strong solution. Best results will be obtained if commercial dyes are purchased from leather-supply companies.

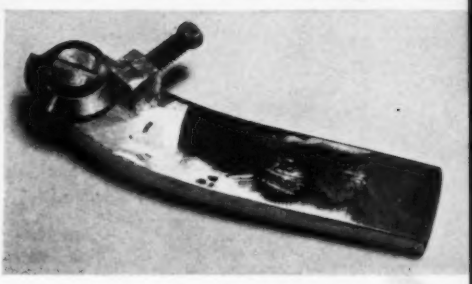
Before dyeing natural leather, first clean the surface thoroughly. A commercial cleaning solution may be purchased, or a very weak solution of hydrochloric acid and water may be made (1:20 ratio). Take a soft cloth and dampen it with the cleaning solution. Rub the surface of the leather lightly. Allow the leather to dry slightly before starting to dye it.

Always test the dye on a piece of scrap leather. Flow on the dye with a soft brush. After it has dried, a second coat may be applied if a darker effect is desired. Use a small camel's-hair brush to apply dye to all cut edges of leather, being careful not to get dye on the finished surface. Two-tone effects may be obtained by applying spirit dyes to leather that is already colored.

Allow ample time for the dye to dry, and polish the surface lightly with a clean, soft cloth.

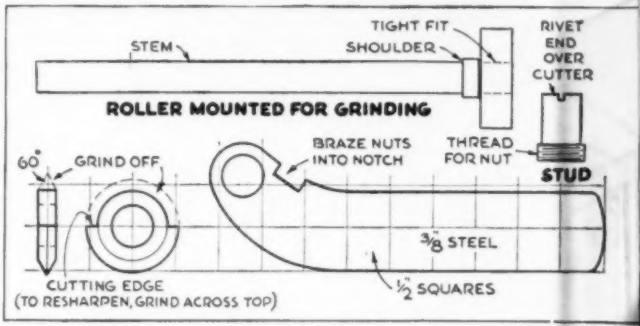
POPULAR SCIENCE MONTHLY SHOP DATA





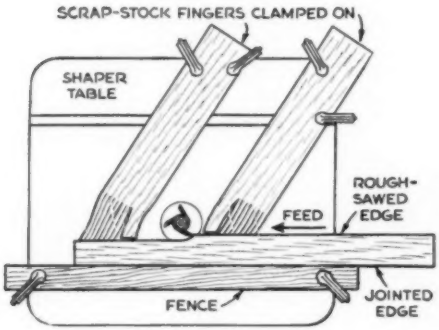
Formed Threading Tool Ground from Auto Tappet Roller

THIS homemade formed threading tool can be resharpened quickly, yet always cuts the correct thread angle. The cutter is ground from a hardened roller found on the tappet rods of some old automobiles; such a roller can be had for a few cents at most auto-wrecking yards. It should be mounted on a shaft for grinding to the standard 60-deg. V-thread profile. This can be done on the lathe with the aid of a tool-post grinder, or on a valve-grinding machine.



When the proper shape has been obtained, grind back more than half the circumference to a radius of ⅜". Be careful at all times during grinding not to heat the piece enough to draw its temper.

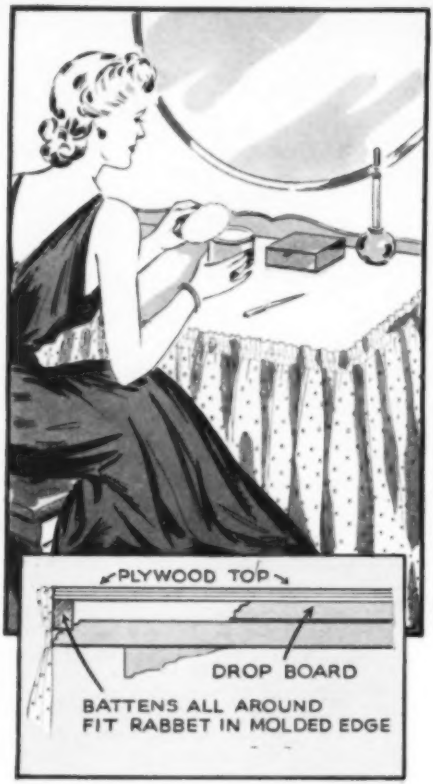
A shank is forged from a piece of scrap steel ⅜" thick and drilled for the stud. Into a filed notch braze two ¼" nuts for the setscrew. Turn the steel stud to fit the hole in the cutter, thread one end for a thin hexagon nut, assemble on the shank with the cutter, and rivet the head of the stud over. To resharpen, grind only across the flat top of the tool, as indicated.—B. N.



Guides Align Work on Shaper

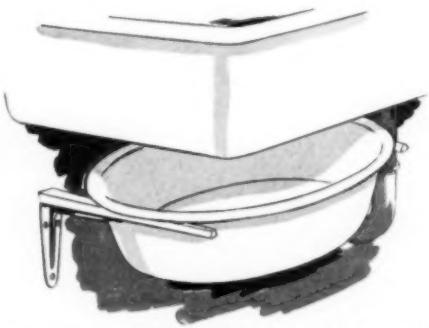
SETTING up a wood shaper as at the left will enable you to reduce any number of pieces to uniform width. The work is jointed on one edge and sawed 1/16" oversize. Clamp on the shaper table at the required distance from the cutter a piece of stock with one jointed edge. Two spring "fingers" made of scrap are of the conventional type, but each has a strong piece left on the side nearest the cutter. These "thumbs" should barely clear the work. They prevent it from being drawn into the cutters as it is pushed through.—XURY R. SETTLE.

KEEPING THE



An old-style drophead sewing machine that is used infrequently can be concealed by transforming it into a vanity table for that extra bedroom. Fit to it a plywood top with a low ornamental back and a draped cloth skirt. Battens all around fit into molding rabbets or otherwise hold the top, which can be lifted off when sewing is to be done

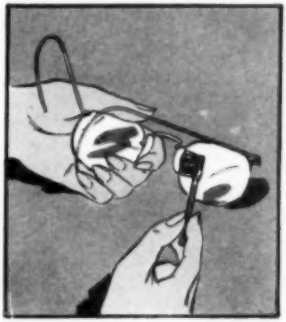
Strips of absorbent cotton wrapped around the wrists while walls and woodwork are being washed will catch annoying trickles of water before they roll down the arms. Rubber bands hold the pads



Dishpans can be kept neatly under a kitchen sink, utilizing otherwise waste space, by installing two metal shelf brackets to which are screwed strips of wood as illustrated above. Space the brackets so that the strips will fit the rim of the largest dishpan used in the kitchen. Smaller ones may, of course, be stored by nesting them inside the first

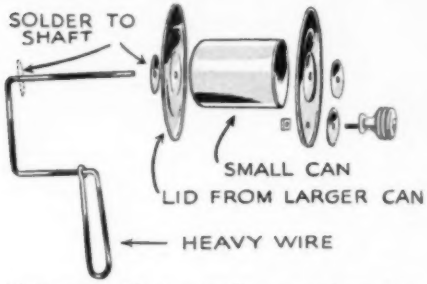
Syrup pitchers having colored plastic tops and spring spouts make handy lotion dispensers

To open a cloth salt or sugar bag easily, rip from the right while facing the single thread

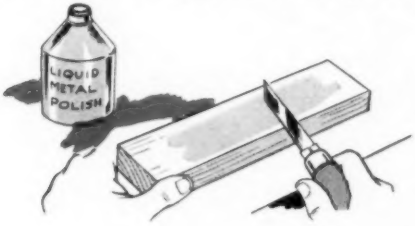


Used with a liquid cleanser or soap, a mascara brush will help in cleaning eyeglass fittings

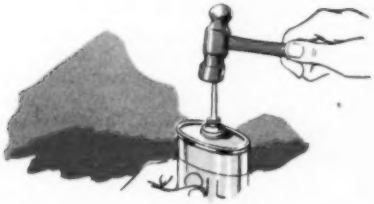
HOME SHIPSHAPE



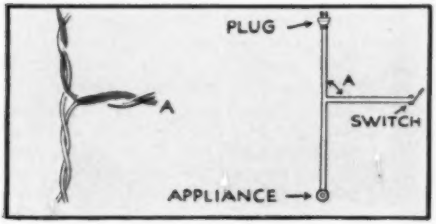
Solder tin-can lids to a smaller can and mount on a bent-wire axle between soldered washers or bits of tin, as indicated above, to make a cord or clothesline reel. The knob is taken from a pot lid



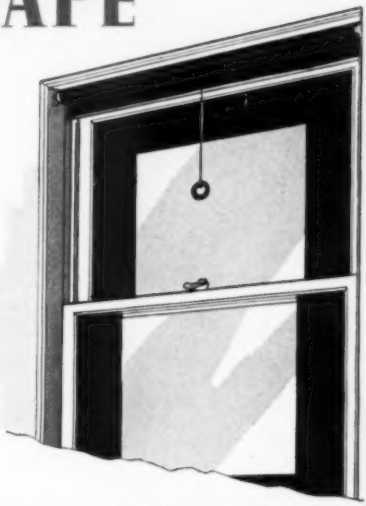
After sharpening a knife on an oilstone, strop it on a block of smooth white pine, wet with liquid metal polish, to get a keener edge for fine work



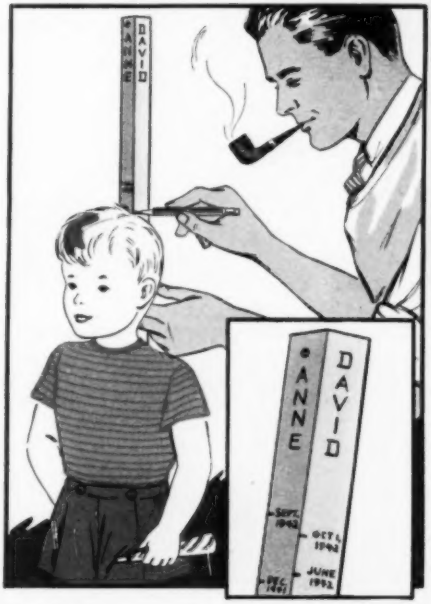
Household oil is often wasted because an oil-can spout lets out more than is needed. Hammer the opening in the end almost shut to slow the flow



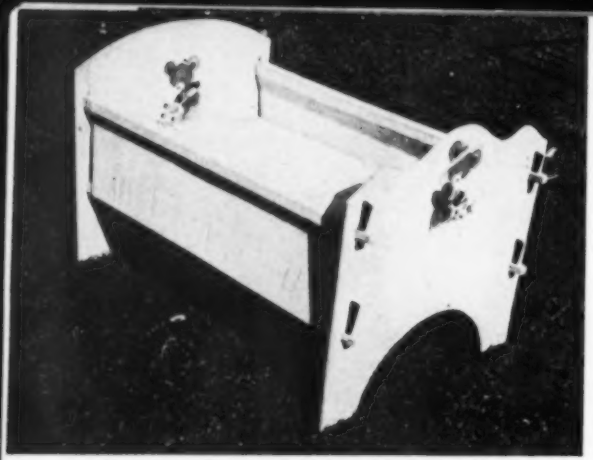
Neat wiring extensions to a cord switch or the like may be made by separating the original wires back to the branch and twisting in an extra one

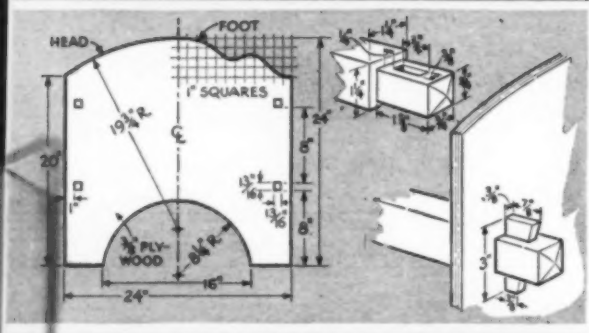


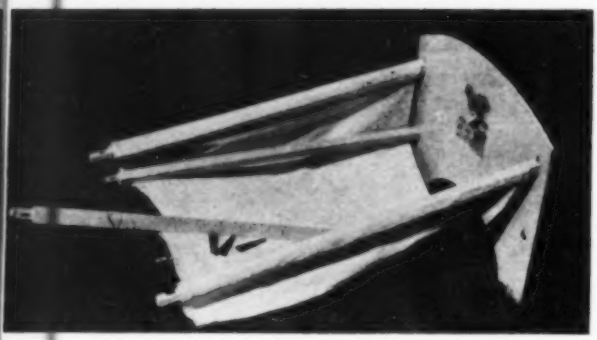
Black paper in 4" wide strips pasted on the borders of a window will keep any light from leaking at the edges if used in conjunction with a black shade of regular window width. The sash is simply closed and the shade drawn at a blackout signal, eliminating the delay of taking out and hanging special equipment



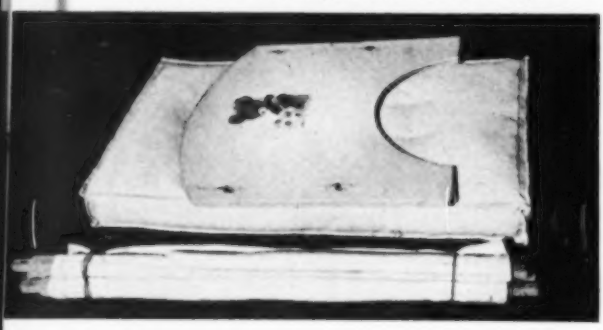
Height of children can be recorded permanently on a 1" by 1" pine pole. It is well to apply clear lacquer to the marks occasionally to preserve them







Above, how the portable bed is assembled. Below, knocked down and with mattress packed, the bed is easily carried



TAKE-ALONG *Baby Bed*

By HELEN BRIDGE POHLMAN

A YOUNG Marine officer designed this portable bed, which solved the problem of providing a sleeping place for his baby in hotel rooms, furnished apartments, or at the homes of friends. It is light, inexpensive, and can be knocked down or assembled in a few minutes. The original shown here was used until the child was two years old.

Even an inexperienced craftsman should have no trouble in making such a bed. Only hand tools are needed, plus a 24″ by 48″ sheet of ⅜″ plywood, 14′ of 1¼″ by 1¼″ lumber, a 35″ by 52″ piece of strong canvas with hemmed edges, wood stain, and paint.

The shape of the ends may be varied to suit so long as the general dimensions are retained. Make the square openings for the poles by boring through with a ¾″ bit and shaping the holes with a coarse file. If the head and foot of the bed are clamped together for this operation, the holes will match up perfectly.

Tenons are cut on both ends of each pole as shown in the drawing. Drill two 5/16″ holes in each tenon and cut through between to form the ⅜″ by ¾″ mortise. The wedges can be cut from scraps of plywood.

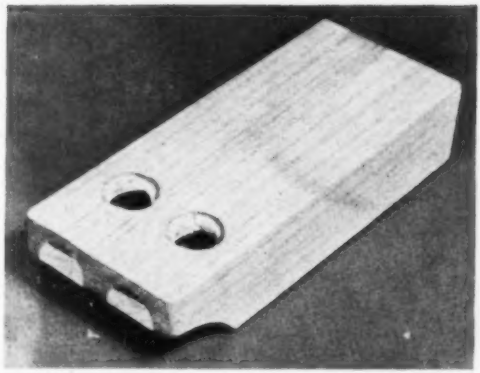
Push two poles through the hems of the canvas, or tack the latter on. The bed is assembled by using these poles as the upper rails, and simply passing the canvas around and beneath the lower poles. This supports the mattress. The wedges clamp the rails securely in place.

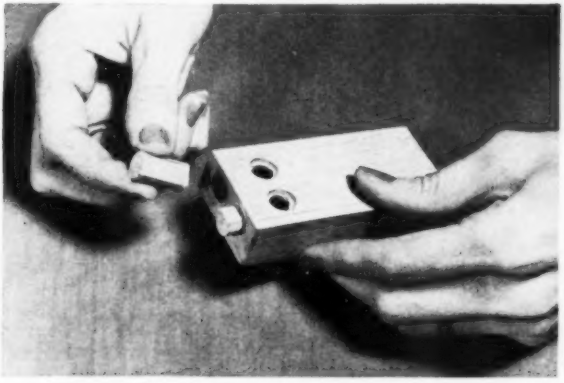
It was found more practical to stain the wedges and poles than to paint them. Any desired color can be used for the two ends. Be sure to sandpaper the edges of the plywood smooth before painting. Decalcomania transfers add a colorful touch, as illustrated in the photograph at the top of this page, where the take-along baby bed is shown set up with the mattress in place.

Two-Tone Wooden Whistle Imitates Locomotive

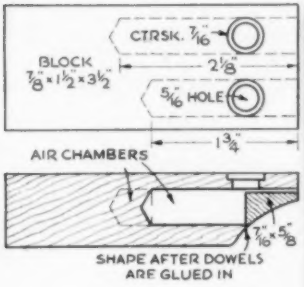
IN A VERY few minutes anyone can make this two-toned whistle, which imitates those on locomotives. Children are sure to like it.

In a wooden block 7/8" by 1½" by 3½" bore two holes lengthwise with a 7/16" bit as shown in the drawing. Bore a 5/16" hole in the top 5/8" from the end to meet each of these as shown. Short pieces of 7/16" dowel are whittled or sanded flat on one side and glued into the holes in the position indicated in the drawing and in the lower photo. Once the glue has set, the underside can be shaped to fit the mouth. The whistle is then sanded smooth, but not painted.—B. N.

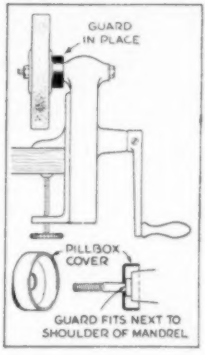




Bore four holes in a wooden block, fit in two short dowels, shape the mouthpiece, and the whistle is made



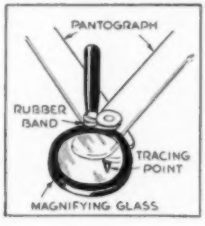
Guard Keeps Emery Wheel Free of Oil

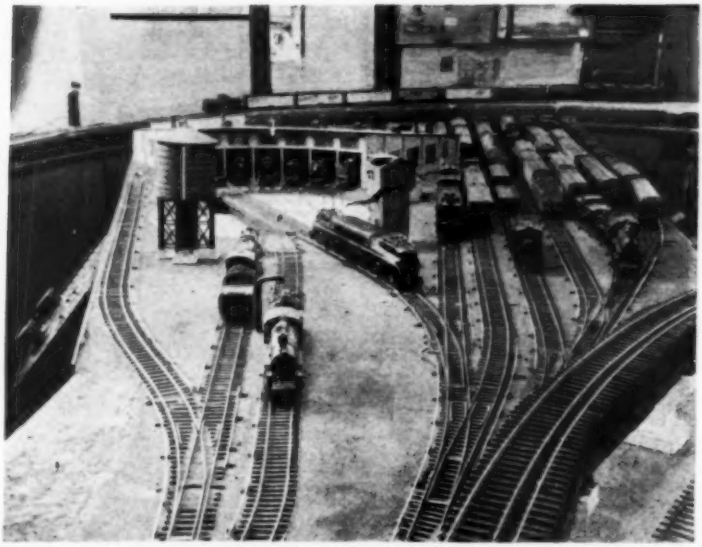


AFTER oil leaking from the bearings had thoroughly soaked one emery wheel on a hand grinder carried about in a tool kit, this annoyance was ended by mounting an arbor guard on it. A metal pillbox cover just big enough to clear the bearing was drilled to fit over the mandrel and against the shoulder, and the collar and wheel were then replaced as usual. A guard of this type will keep oil off the stone both when it is in use and when it is in the tool box. Accumulated oil should be wiped out occasionally.—X. S.

Magnifier Used on Pantograph to Assure Accurate Tracing

WHEN an ordinary pantograph is used, a small magnifying glass fastened directly over the pointer is a real help in tracing the drawing to be enlarged or reduced by enabling the draftsman to see more clearly the lines he is following. The magnifier is placed as shown in the accompanying drawing, and the handle bound firmly to the adjusting nut of the tracer with a rubber band. The band will hold the glass without allowing it to slip while tracing is being done, yet is flexible enough to permit it to be shifted to any desired position very easily.—JAMES N. LARSON.





Switchwork in the engine yard on the Union Dock & Terminal Railway—irreverently known as the Up, Down & Twisty. This was built by members of the New York Society of Model Engineers as the 00-gauge sister line of their famous 0-gauge Union Connecting Railroad

MODEL-RAILWAY SWITCHWORK

1. THE FROG

By DAVID MARSHALL

IN FIG. 1 we have a single-track junction, or what is known, technically, as a turnout. Within this are two principal structures, a switch and a frog. The switch is merely the movable element; it comprises only the points (*X* and *Y*), plus the tiebars that link the points to each other. The frog, on the other hand, is essentially a mortising together (*F*) of two rails to form a crossing—to provide channel room for the flanges of the wheels, and, at the same time, to create an unbroken riding surface for the treads. The frog, therefore, is a rather remarkable contrivance and we pay special attention to it as we launch out upon a discussion of the construction of switchwork generally.

Before we begin, however, the reader would do well to study Fig. 1, which is schematic but fairly close to scale. Model railroaders are notoriously afraid of switchwork, mainly because their knowledge of the subject is vague.

Your first step, therefore, must be to realize the utter simplicity of a turnout; to know precisely what it is and how it works. Simplicity of another sort is also to be discerned in Fig. 1, almost every line of which is straight. The point is, that all the drivers of a locomotive, according to correct practice, must be on straight track to approach a frog, and must continue on straight track till all have cleared the frog. The rule is also to make both *X* and *Y* absolutely straight, and to give to the diverging stockrail (*CD*) a curve (at *E*) of the smallest possible chord—though that's a subject to be dealt with later on.

THE ANGLE OF THE FROG. Four rails enter into the structure of a frog—the two *wing rails* that flare out of *M* and *N;* and the two rails that meet, and are mitered together, to form the triangular element, or *tongue*. In Fig. 1 the tongue is contained in the angle *HFG*, which is thus known as the *angle of the frog*. All the dimensions of the turnout depend upon this angle.

To simplify things, however, railroad engineers have standardized the angles. Avoiding even the use of degrees, they classify a frog according to the altitude of the triangle in proportion to a unit base. If the ratio is 6 to 1, for example, you have a No. 6 frog; if it's 7 to 1, you have a No. 7 frog; if 8 to 1, a No. 8 frog—and so on up through a dozen or more strictly standard sizes. From the angle, thus, we deduce the *number* or *size* of the frog; and once we know this, we know all the dimensions of the turnout—for they are all worked out for us in advance.

The model railroader would do well to standardize on Nos. 6, 7, and 8, and forget about any other frogs. The first of these is

the smallest permissible under the rules of the National Model Railroad Association; and since most equipment manufacturers now follow NMRA standards, you had better do likewise—or you may find yourself, some day, with locomotives that can't be operated on your pike. Experienced model railroaders, on the other hand, agree that No. 8 is adequate for the highest of high-speed switches, while No. 9 takes up more space than can usually be afforded.

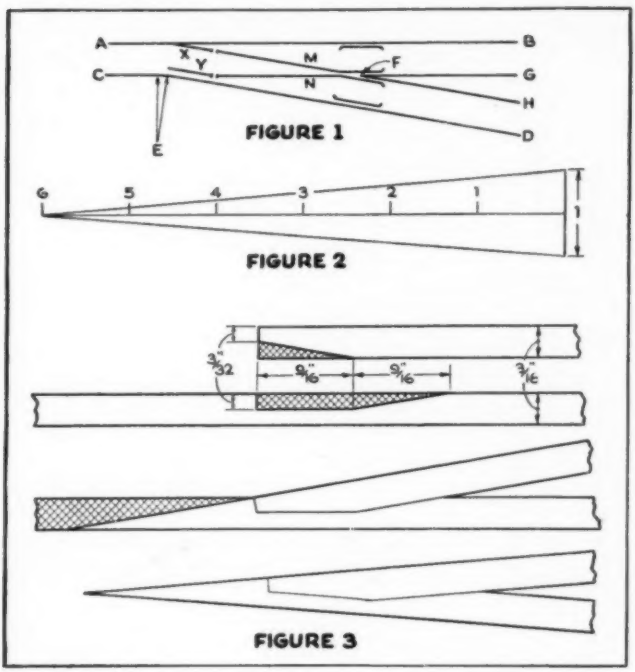
THE TONGUE. In constructing a tongue, you can always be sure of yourself if you first lay out the angle of the frog on paper. All you need do is take a straight line of any given length, lay off the requisite number of lengths along its perpendicular bisector, and complete the triangle. The angle of a No. 6 frog is thus laid out in Fig. 2 with absolute precision. When you have done that, all that remains is to fit the two rails together so as to form an angle contained exactly in the apex of this triangle.

But how to fit these rails together? For a new and simplified method we are indebted to the railroad-engineering department of the New York Society of Model Engineers. A tongue made by this method appears full size in Fig. 3, and all three steps in the shaping and fitting together of a No. 6 job are illustrated. The dimensions are based on the assumption that you will use an O-gauge rail having a breadth across the flat bottom of 3/16". The use of these dimensions, however, is merely to illustrate. In practice, you consider simply the ratio—6 to 1 for a No. 6 frog; 7 to 1 for a No. 7 frog; 8 to 1 for a No. 8 frog.

The upper rail is "prepared" by filing off one end of it a triangular section half a rail wide and six times half a rail in length. Likewise, the lower rail is prepared by two filing operations in which the same 6-to-1 ratio is repeated. The final operation consists in fitting the two rails together and shaving the lower one to a point along the straight line established by the edge of the upper rail.

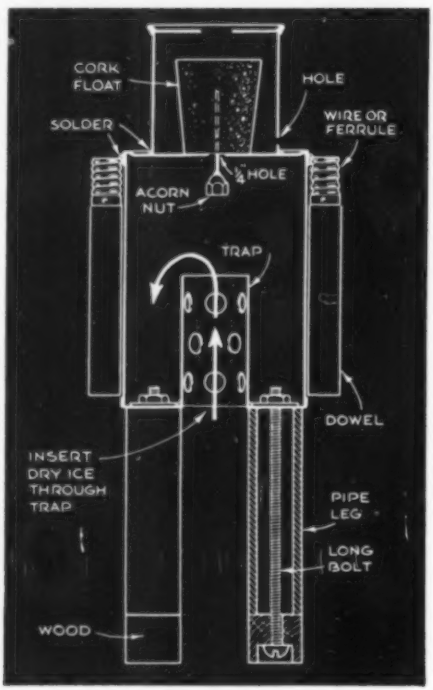
It is important to notice that precision is quite alien to this method, just as it is on the grown-up railroads. You lay out the work roughly—half a rail deep and 6 (or 7 or 8) times that the other way. Then your file goes into action swiftly, and not too meticulously. Next, you try them together, and see what else is needed. Be sure the outer edges of both rails follow the lines with reasonable accuracy. And if the seam between the rails is not accurate—forget about it. You can fill up the crevices with solder.

It is also important to note that all this work can be done "on location." When you are laying track "by the mile" and come to a point where switchwork of any sort occurs, you simply "prepare" each rail at the place indicated and go on with your main-line work. Thus the final step of shaving to a point the lower rail in Fig. 3 will normally not be approached until long after both rails have been spiked firmly into position. And if it should then appear that the rails meet at a wrong angle, you are in a position to make things right simply by accepting the angle as you find it.



DESIGN OF SWITCHES

Almost every line of a switch is straight (Fig. 1); the angle is easy to lay out (Fig. 2), and the construction of a frog is simplicity itself (Fig. 3)



Deep-Sea Diver

OPERATES ON DRY ICE

WHEN Diver Dan is at work, children—and grownups too—watch spellbound. This robotlike figure sinks into the water, remains out of sight for a time, and mysteriously emerges, only to repeat the performance a few seconds later. "How does he do it?" is the inevitable question.

For all his mystifying behavior, the diver is easy to make. Pry off an end of a tall evaporated-milk can, heating it to melt the solder. Cut a 1" hole in this end and solder in a perforated tube bent from scrap tin plate, as shown in the drawing. Attach iron-pipe legs and wooden feet with long bolts and nuts.

Solder shut any holes in the top of the can; then punch a clean ¼" hole in the center from the *inside*. To a piece of wire, solder an acorn nut; insert the wire in the ¼" hole and push on a 1" cork as shown. Cut off one end of a smaller can and make a ½" hole in the other, as well as two small holes for eyes. Solder this can, open end down, to the top of the larger can. Be sure to punch a small hole near the joint as indicated in the drawing.

Replace the bottom of the tall can and "tack" it on with solder. Finally, solder on tin-plate tubes or wooden dowels with wire or metal ferrules as arms.

To put Diving Dan to work, drop a small piece of dry ice (solid carbon dioxide) through the trap in the bottom, and tilt the can so that the piece falls back inside. Use tongs in handling dry ice—*never* touch it with the bare hands, for it can cause a serious burn. When dropped into water a few feet deep, the diver promptly sinks, but the cork then rises, shutting the air valve. Gas given off by the dry ice is thus trapped, and drives out the water, bringing the diver again to the surface. Above water the cork drops; the gas escapes, water enters again, and the cycle is repeated. Dry ice *must* be used; ordinary ice will not do.

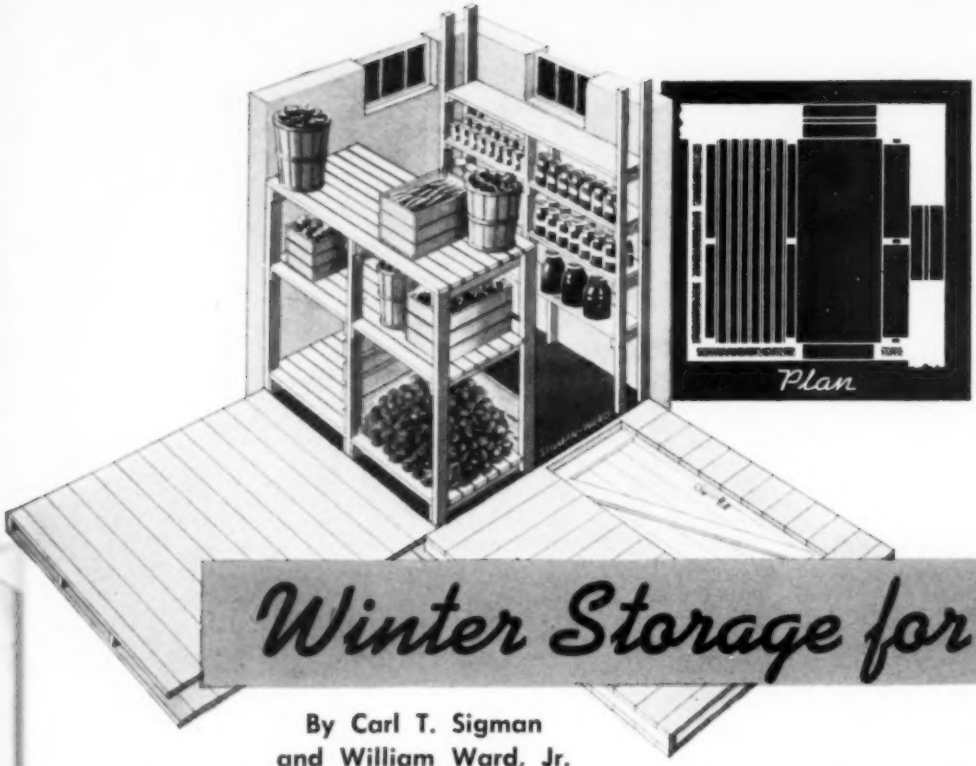
If the diver does not rise, cut the legs somewhat shorter to lighten them. It is a wise precaution to attach a cord "life line" by which Diving Dan can be rescued if the dry ice gives out and leaves him stranded at the bottom of the lake.—LOUIS NICOLOSI.

NEW APPLIANCES to aid in *Housekeeping*

A CHILD'S HEIGHT can be measured with accuracy and a minimum of fussing around to keep the subjects still if the bathroom measuring device shown at the right is employed. The operation consists of adjusting the sliding unit of the gauge so that the ball on the end of its rigid arm touches the top of the child's head. Then, just above the arm where reading is easiest, a slot in the sliding element shows the exact record of the height. The gauge is easily installed on the bathroom wall, either permanently with a screw driven into a fiber bushing or by hanging it on a screw hook. To check the accuracy of the initial installation, try the gauge with a yardstick

PLASTIC UPHOLSTERY FABRICS are available for home furnishings in a wide variety of colors and weaves, many of them resembling high types of cotton, wool, rayon, or silk. The material is stainless, nonporous, flexible, and tough, and, heated by fire, will melt slowly but will not burn. It does not retain heat when exposed to the sun, and withstands rain without absorbing moisture. Dirt can be removed with soap and water, and such stains as those from ordinary ink—illustrated in the photograph above which was taken during a demonstration—can be cleaned by rubbing with a dampened brush. At present the fabric is used also on auto, bus, train, and plane seats

SUGARLESS SWEETENING in the kitchen in the preparation of favorite desserts is the subject of an interesting cookbook recently published. Corn syrup, maple syrup, honey, and molasses are used as the principal ingredients in place of the customary sugar, and, the author argues, are as sweet or sweeter, more nutritious, and less fattening. Honey, for example, is said to be just three times as sweet. Among the recipes given in the book for familiar good things to eat usually found on the average American table are ones for making lemon meringue pie, apple pie, cookies, brownies, layer cakes, and many frostings — all without using any sugar



Winter Storage for

By Carl T. Sigman and William Ward, Jr.

IF YOUR Victory Garden has been the success you hoped after so many weeks of spading, planting, transplanting, cultivating, and bug killing, you are now in the midst of plenty. So much so, it may be, that you have begun to wonder what you are going to do with your bumper crops. Tomatoes, sweet corn, peas, and beans have been, or will be, canned. But have you thought of how you are going to keep potatoes, parsnips, carrots, beets, cabbages, onions, squash, pumpkins, apples, and pears in good condition for winter use?

Even if you have no Victory Garden, vegetable storage may interest you, because with proper storage facilities and methods you can buy fresh fruits and vegetables as they come in season, when their cost is low and their quality high.

Most vegetables keep best at temperatures from 34 to 38 deg., though some can stand a few degrees of frost, and the quality of some few others is even improved by freezing. The average basement is too warm and dry, hence you need a storage room as well insulated as possible from the heat and dryness.

At the head of this page is shown an easily built fruit, vegetable, and canned-goods storage room. Two of its sides are basement walls, one of which should face north. There must be at least one window in the room, and if in the northeast or northwest corners you have two windows, you will have the extra advantage of cross ventilation. Common 2″ by 4″ studding provides the vertical bracing, and 1″ boards are nailed horizontally to this. For best results, use one of the fill-type insulation materials, such as rock or balsam wool, between the studs, first tacking a waterproof felt or building-paper backing to the inside boards to prevent the dampness you need in the cold room from penetrating to the insulation. Also be sure to build a heavy, well-fitting door, similarly insulated, if possible.

The storage shelves may be made of 1″ by 3″ or 1″ by 4″ boards spaced for ventilation. Below these, for potatoes and root crops, are similarly ventilated bins, raised off the floor for additional circulation. Open-slatted crates and baskets should be used on the upper shelves to hold cabbage, apples, pears, and the like.

Darkness is as important as temperature and ventilation, so paint the windows black or cover them with burlap. Also be sure that they are well screened to keep out flies and vermin. Open the windows during the cool nights in the fall, and close them again in the daytime, to keep the cool air in and

the light out, and to prevent "sweating," which occurs when warm air comes in contact with the chilled vegetables. Sweating hastens spoilage.

Stored vegetables also must be kept moist or they will shrivel. Earth or brick floors are superior to concrete, because concrete dries out rapidly and absorbs the vegetables' moisture. Your basement probably has a cement floor, so you will need to counteract its drying action with flat pans of water and by sprinkling every day or two. Better still, cover the floor with several inches of moist earth, sand, or peat moss. Either process of evaporation will prove an added blessing by acting as a cooling agent. Be sure to keep the room clean to retard the growth of bacteria.

Perhaps you have space to build a properly ventilated storage room under a large bay window or a projecting small room so in the garden. Though not so accessible, they keep better because in the soil a high and uniform humidity is possible.

Simply dig a trench 10" to 12" deep and 5' to 6' wide in a well-drained spot. Line this with 6" to 8" of straw, leaves, marsh hay, or pine needles. Pile your crops—carefully, to avoid bruising—in cones about 30" high, which you then cover with straw, hay, or clean burlap, as in the drawing below, allowing a generous tuft to project through the top for ventilation. Just enough soil is placed over the cone to hold the covering in place. As the weather gets colder, more soil is added. Finally, place a stone or board on top of each pile to keep out rain. If you have a series of these cones, instead of storing beets in one pile and potatoes in another, store a miscellaneous group in each, and dig up only one cone at a time.

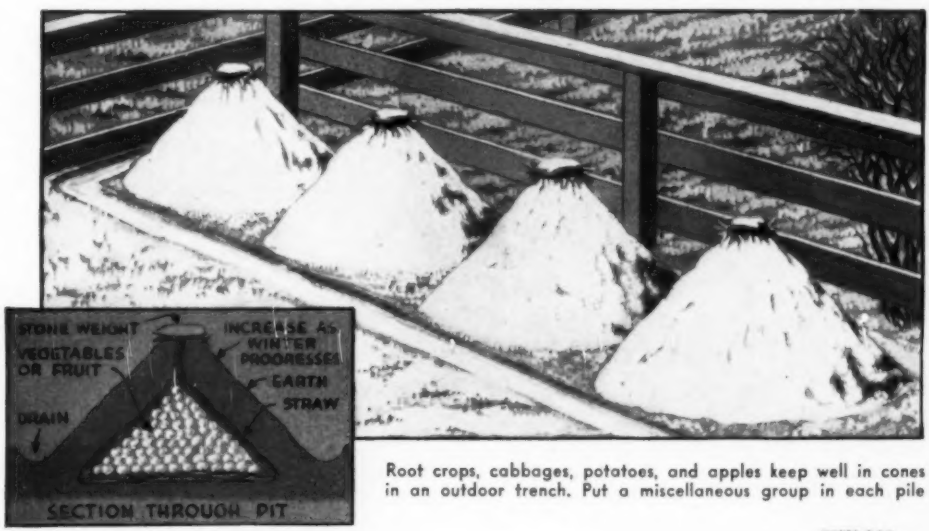
Another satisfactory method is possible

Your Victory Garden

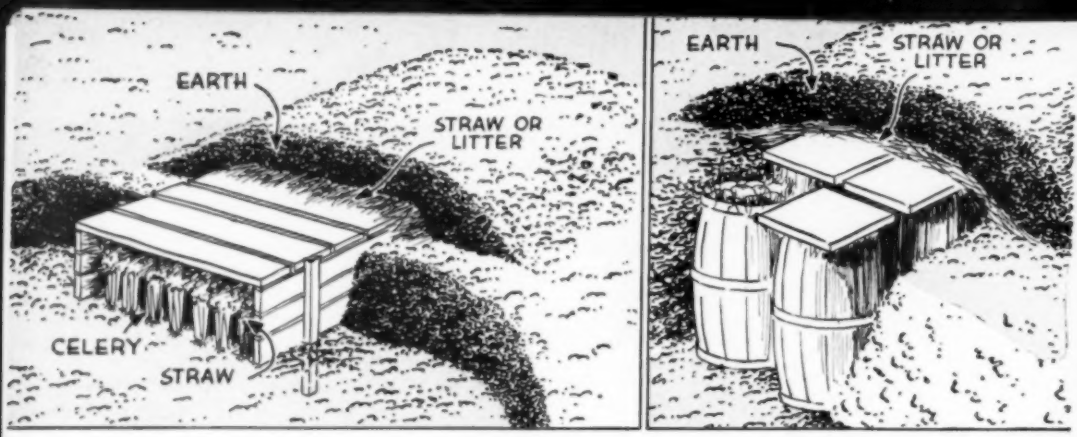
that you need to erect one wall instead of two. Best of all, you may have facilities for building a cellar underground with an entrance either from the basement or the outside. This, however, is expensive construction, and ventilation is more difficult.

But storage in cold rooms is not the only means, nor always the best method of keeping vegetables. Root crops, cabbages, potatoes, and apples may be buried with the use of old nail kegs as shown in another drawing. These kegs should be lined with straw, hay, or even old newspapers, then filled with perhaps a week's supply of vegetables. Bury these containers in a corner of your garden and cover each with a board over which is placed a generous layer of straw or hay. Cover the whole with soil.

Having provided proper storage, let's



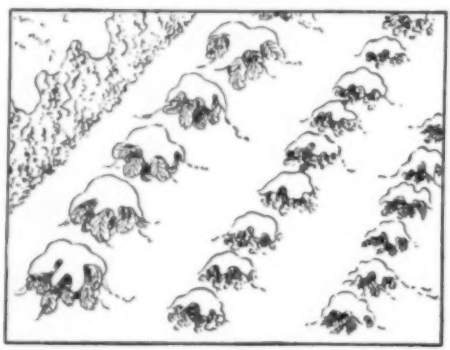
Root crops, cabbages, potatoes, and apples keep well in cones in an outdoor trench. Put a miscellaneous group in each pile



Celery keeps best standing in a trench under an inverted trough and covered as at left above. Nail kegs, lined with straw or even newspapers and buried, afford another way of storing vegetables outdoors

consider what kinds of vegetables should be stored, and how. Potatoes being such an important part of our diet—for some who are overweight, too important—might well be considered first. White potatoes, when stored indoors, should be placed in bins. In shallow containers they lose moisture and shrivel. Warmth and too much moisture cause them to sprout, while light makes them turn green.

Sweet potatoes are different. After they have been dug and allowed to dry for several hours, they should be placed carefully in a slatted container in a warm, dry place for three or four weeks. Then they can be transferred to a cool, *dry* place—not your storage room because that is moist. Handle sweet potatoes, indeed all vegetables, as little as possible to prevent bruising, which encourages decay. Squash and pumpkins can't be kept in your storage room either, because they require a warm, dry atmosphere. Store them, with at least 2" of stem attached and in no more than double layers, on shelves near the furnace. About 60 deg. is the correct temperature.



Kale, Brussels sprouts, parsnips, and the like may be left in the garden. Such hardy crops survive freezing temperatures and may be picked as needed

Onions keep well in a cool, dry place, such as the floor of your attic. Those grown from seed keep better than those from sets.

After having filled your crocks with "kraut," you may still have cabbage left over. Late varieties can stand light frost, and may be left in the garden until mid-November. Then pull up sound plants by the roots, wrap them in paper, and place them in crates in the cold room.

Beets, turnips, carrots, rutabagas, and kohlrabies should be rather young and tender since older plants tend to get woody. Twist off all except 1½" of the tops, then store in crates, or for best results place them in the cold room in moist earth and dig as needed.

Lettuce, celery, endive, and leek can be kept in cold storage from two to four weeks. By leaving them in the garden until heavy frost is expected (they can stand light frosts) they may be edible almost until New Year's. Celery can be kept best in a trench, as shown above. Place good firm plants in it close together with their roots on and the older, diseased leaves removed. Cover them with an inverted troughlike cap, then with plenty of straw or hay, and finally earth.

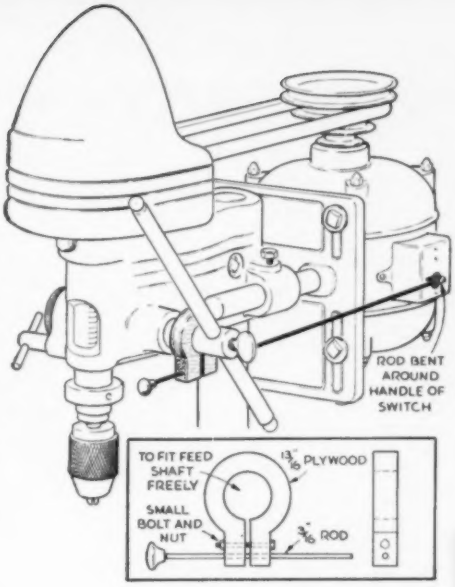
Well-matured green tomatoes will ripen in subdued light when kept on shelves at 60 to 65 deg. temperature in one or two layers.

Brussels sprouts and cauliflower will stand light frosts. Before freezing weather, cauliflower plants with developed heads may be transplanted, roots and all, in boxes filled with soil or sand and placed in your cold storage room. In storage they will increase in size.

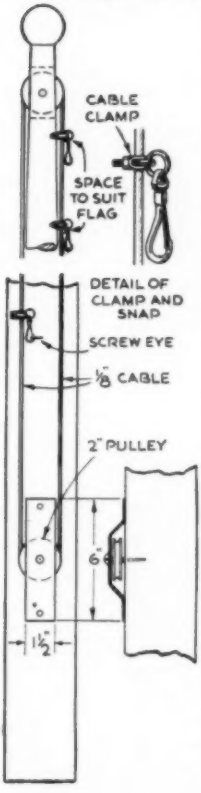
If you haven't room indoors, you can leave kale, parsnips, horse-radish, and root parsley in the garden all winter, though freezing and thawing may injure them.

Drill-Press Switch Extension Gives Finger-Tip Control

THREE hands would be useful when using the drill press for routing and many other high-speed freehand operations — two to hold the work, another to start and stop the motor. Lacking the third hand, why not bring the motor switch closer to those holding the work? Saw a collar out of 13/16" plywood and mount it with a bolt to ride snugly but freely on the lever-feed shaft. Under the bolt drill another hole to a sliding fit for a length of 3/16" rod. Bend one end of this around the switch lever, and fit a knob to the other. A push or pull of $\frac{1}{2}$" operates the switch.—L. L. GIBSON, JR.



Pulley Near Base of Flagpole Helps in Raising Colors

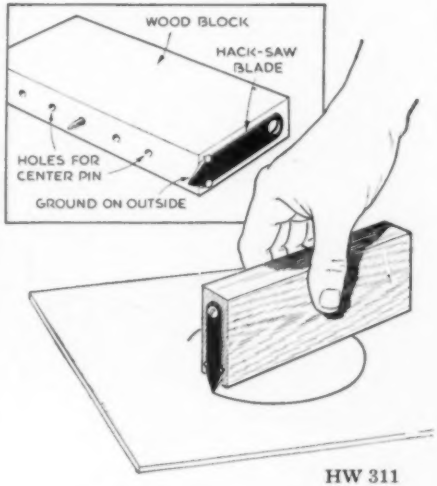


Sash wire threaded through two pulleys on a flagpole makes a foolproof halyard

DIFFICULTIES experienced with flagpole halyards, especially at schools, can be eliminated to a large extent by the use of a second pulley about 8" from the base of the pole. One taken from an old awning or window sash, or any other kind available, will serve nicely. Galvanized sash wire is threaded through both pulleys and joined taut with a cable clamp, on which is fitted a spring snap to hold the top of the flag. The less slack allowed in the wire, the smoother it will work. Attach another clamp and snap below the first to hold the bottom of the flag, and raise the flag to its full height. Then put a third clamp and snap near the lower pulley on the wire that will go up when the flag is lowered, and fasten it to a ring or eye screwed to the pole. Unsnap to lower the flag. A padlock in the ring and any one snap prevents tampering.—PERRY HYAMS.

Hack-Saw Blade and Block Form Useful Fly Cutter

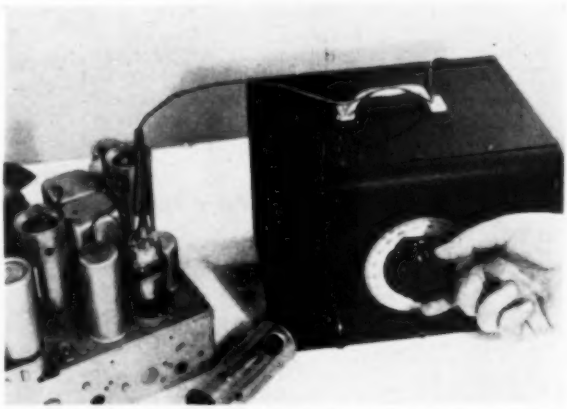
ROUND holes can be cut in cardboard for models, displays, and the like with a fly cutter made from a small block of wood and an old hack-saw blade. Drill a series of holes about $\frac{1}{4}$" apart in one edge of the block to receive the pin that serves as a pivot center for holes of various diameters. Break a short piece from the end of the hack-saw blade, grind it as shown, and attach it to the end of the block with a wood screw and two small nails. To make a clean hole, cut the cardboard first on one side and then on the other.—IRVING SALZER.



Portable AC-DC Signal Tester

Oscillator Can Be Used as Wave Meter on Broadcast Band

By ARTHUR C. MILLER



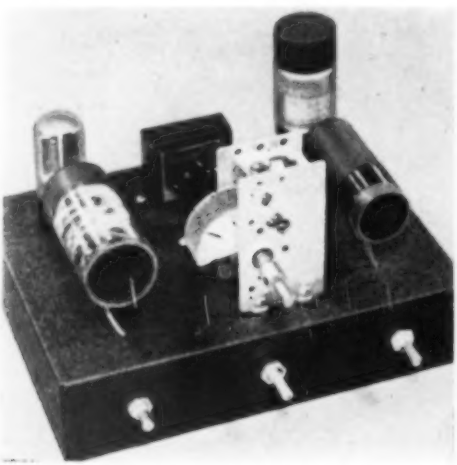
Oscillator shown in use with test prong hooked to screen grid cap

INEXPENSIVE to build, this portable AC-DC test oscillator recommends itself to present conditions, for it may be used either in the shop or taken out on calls. It operates on both AC and DC current and there is no need to worry about which current a customer might have. The latest tubes are used and the output is a pure, audible sound that can be heard easily through the speaker of the set being tested.

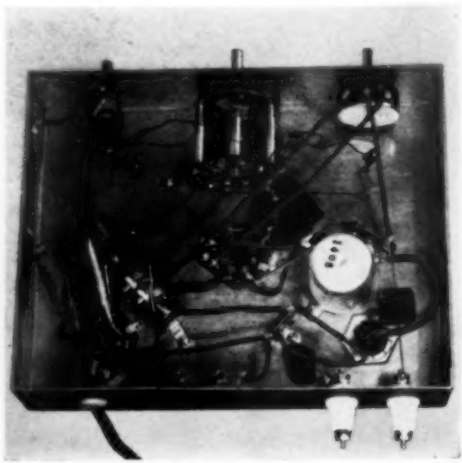
This oscillator will align the I.F. stages of any superheterodyne having a frequency between 300 kc. and 850 kc. Most I.F. stages are peaked at about 456 kc. Additionally it will serve as a wave meter for the broadcast band, enabling one to identify unknown, distant, or local stations. A simple two-tube circuit is used, consisting of a half-wave rectifier (25Z6-GT/G) and a parallel-feed oscillator of the electron-coupled type, (6SK7).

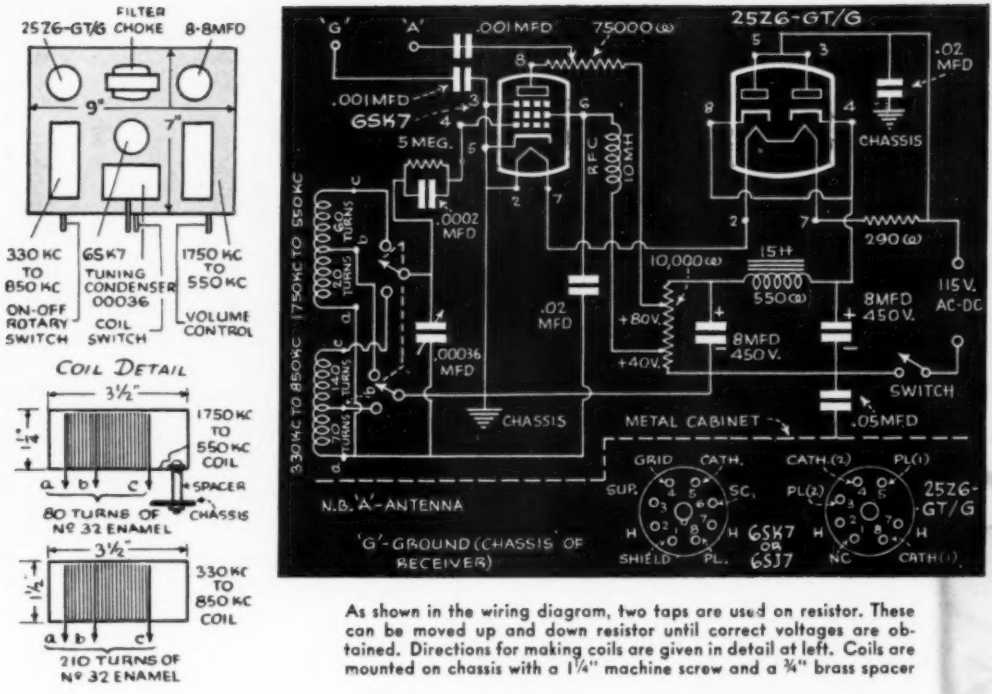
Two coils are needed for this operation, one to cover the 300-kc. to 850-kc. band and the other the broadcast band (1,750 kc. to 550 kc.). Directions for making these coils are in the accompanying sketch. Before using, the oscillator must be completely inclosed in a steel cabinet. A .05-mfd. condenser grounds the cabinet to the chassis. Do not ground the cabinet directly to the chassis, for there is danger of a short, especially where the oscillator is being used on a DC line. The .02-mfd. condenser must be mica insulated and not paper insulated, unless it is non-inductively wound. The simplest way to calibrate the oscillator for

Below, front view of coils on chassis and other parts



Bottom view of chassis, illustrating wiring of unit

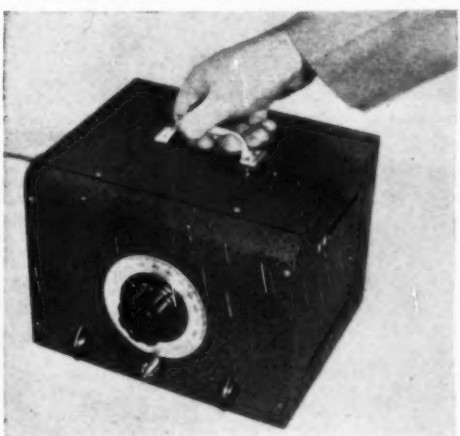




As shown in the wiring diagram, two taps are used on resistor. These can be moved up and down resistor until correct voltages are obtained. Directions for making coils are given in detail at left. Coils are mounted on chassis with a 1¼" machine screw and a ¾" brass spacer

aligning a superheterodyne is to use a good radio receiver having an I.F. frequency of 456 kc. Then remove the grid clip from the first I.F. tube and connect point "A" on the oscillator to the grid cap of the I.F. tube. Rotate the dial until a signal is heard in the speaker. This point on the dial will correspond to the I.F. frequency of the receiver. In order to align the I.F. stages of other sets, tuned to 456 kc., switch the oscillator on and turn the dial to the correct position for 456 kc. The oscillator is now sending out a note tuned to 456 kc. Next, adjust the trimmers on the I.F. coil cans, until the note is heard.

Cabinet with dial, brass handle, and two self-tapping screws appears below. Note its compactness



LIST OF PARTS

Cabinet, 7½" by 8" by 10¼". Black wrinkle finish.

Cadmium-plated chassis, 2" by 7" by 9".

Tuning condenser, .00036 mfd.

Coil form, 1½" diameter by 3½" long.

Coil form, 1¼" diameter by 3½" long.

Filter choke, 15 henrys, 550 ohms.

Dual electrolytic condenser, 8+8 mfd., 450 volts.

Octal tube sockets (two).

Rotary switch, S.P.S.T.

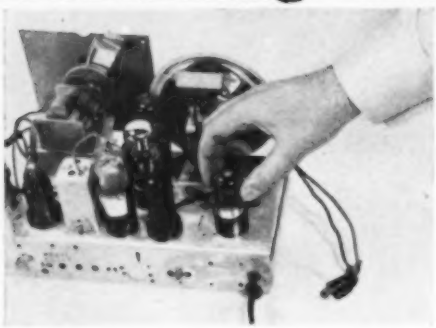
Variable resistor, 75,000 ohms.

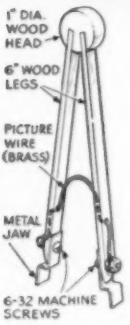
Wire-wound resistor, 10,000 ohms, 25 watts.

Porcelain binding posts (two).

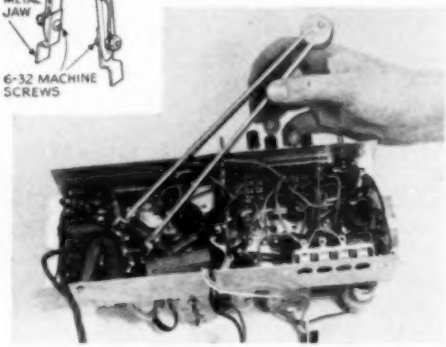
Tubes: 25Z6-GT/G and 6SK7.

Servicing Your Radio—PART 6

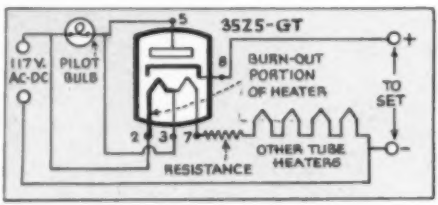




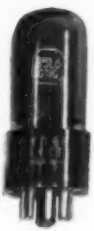
WORK CAN BE SPEEDED UP in servicing old radios with this gadget made from wooden photo tongs, such as is used on wet prints. Switch on the receiver and begin shorting the different fixed resistors. When the defective one is shorted, reception improves.

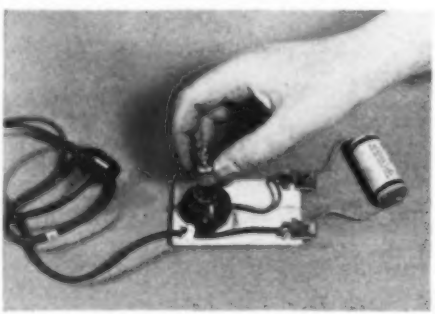


SOME SERVICEMEN HAVE TROUBLE with the AC-DC receivers that use the 35Z5-GT rectifier tube. This is shown by the pilot bulb blowing out when a new tube is inserted and the set is switched on. When these blowouts occur, the section of the tube's heater—just across the pilot bulb—is defective. As the set is switched on, the pilot bulb carries the load and, of course, blows out. The remedy is to replace the 35Z5-GT.

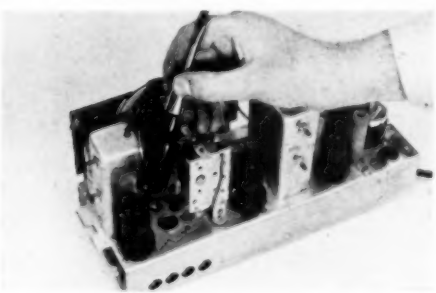


WPB HAS REDUCED TUBE TYPES by some 349 varieties, because they made up only about 1% of the total yearly sales. Smaller GT tubes will replace the larger G types, without loss in output. Sets formerly using a 25Z6-G, or a 25Z6-GT, will now obtain identical results with the 25Z6-GT/G tube.



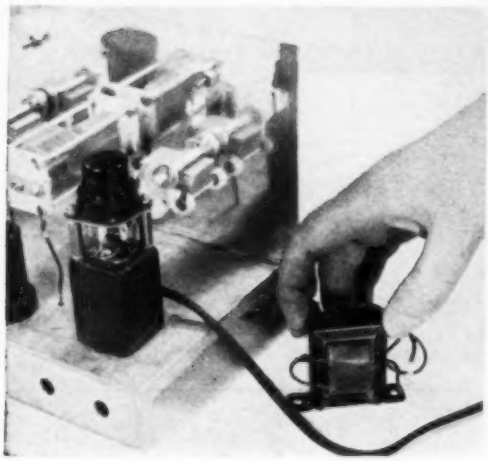


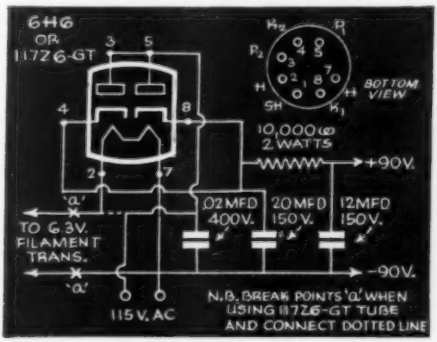
INTERMITTENT AND FADING RECEPTION on some AC-DC receivers and phone combinations is caused by faulty construction of new single-ended tubes, without grid caps. To test for this trouble, tap all tubes with a wooden screwdriver handle, as shown below, and the defective one will induce static. It should be replaced.



A HANDY DEVICE TO HAVE on the workbench is this homemade AC-DC neon condenser tester. It will work with either paper tubular or mica condensers of any capacity. If the condenser being tested is good, the neon will flash once. But if the condenser is leaky or shorted the neon will glow and sputter, giving a clear indication that it should be replaced.

Compact Rectifier Unit Fits Almost Any Radio Chassis

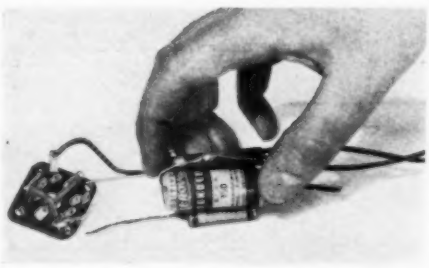




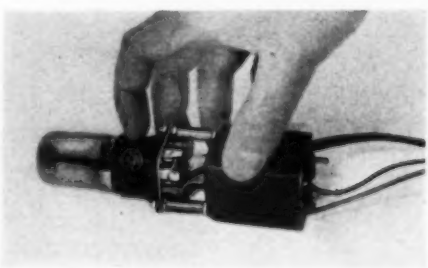
Midget rectifier (at left) mounted on a radio chassis. Filament transformer (on right) is compact and can be easily mounted under chassis. Diagram shows wiring

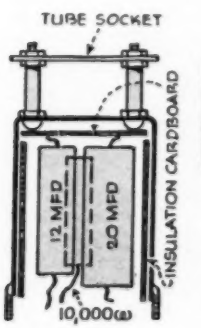
DRY BATTERIES are going to be increasingly difficult to obtain, and many owners of home-built or commercial one, two, and three-tube headphone receivers will have to convert theirs to operate on the electric house current. This is simple with a new rectifier unit, easily built at home and so compact that it will fit almost any radio chassis. It takes up no more room than a tube or electrolytic condenser, and yet contains a complete filtering circuit and rectifier tube! The metal box (1¼" by 1¼" by 2") is an old coil shielding can. Besides the rectifier, a compact (2¼" by 1½") filament transformer with a 110-volt primary and a 6.3-volt secondary (1.5 amperes) is used.

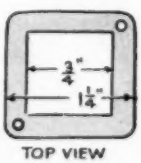
The battery tubes will have to be replaced with 6.3 volt AC-DC tubes of equivalent types. Should the plate current drain be too high to use the 6H6 as a rectifier, replace it with a 117Z6-tube.



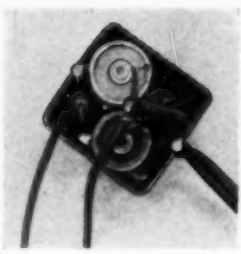
Illustrating how to make a compact "batch" of the condenser and resistor in rectifier, with connections







Left, a cross section of the shielding box, showing the insulation cardboard and, above, top of old coil can



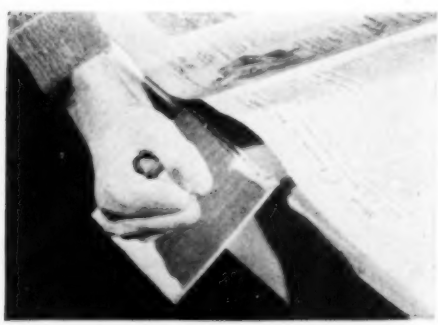
Above is rectifier with a 117Z6-GT tube and 117-volt heater for direct connection to the line. Right, the bottom view of rectifier, showing posts of condensers and resistor

HOME TESTS

YOU can't see it, smell it, or taste it—but air is a mighty handy thing to have around. You'll want some under you if you jump with a parachute, unless you want to attain the rather terrifying velocity of $v = 32t$ — that ever-increasing speed at which physics text-

BALLOON'S ALTITUDE LIMIT. Inflate a toy balloon within a large bottle. Then blow air into, or suck air out of, a hose connection to the bottle as shown. The balloon will respectively shrink, or expand. Likewise a real balloon, only partly filled at sea level, swells to globular shape in the low-pressure air of the stratosphere. If allowed to go too high, it will burst. Filling it with less gas on the ground, or valving off gas at great height, reduces lifting power, thus setting an altitude limit for a balloon of given size. To go higher, the size of the envelope must be increased in proportion to the weight lifted, as in the enormous man-carrying balloons that have set height records.

SCIENCE STUNTS



AIR HAS WEIGHT. Briskly boil a little water in a can. Press down an airtight lid. Remove the can at once from the fire and cool it with water. Steam in the can condenses, leaving a partial vacuum. Balance the can on scales. Pry off the top, and the weight of inrushing air tips the scales. A pint of air weighs nearly ¾ of a gram.

PRESSURE OF AIR. Place a thin piece of wood or cardboard on a table, with about four inches protruding. Now lay two full sheets of newspaper over the stick, and smooth down closely. Press slowly on the protruding stick, and it will easily lift, as air seeps under the paper. Strike the stick smartly with your fist, and it will break.

WITH AIR

books assure you of falling in a happily fictitious vacuum. Frail as it may seem, "thin" air provides ample support for aircraft weighing many tons. And in your ıome laboratory you can actually weigh air, demonstrate ıts pressure, and observe its other properties.

HOMEMADE ANEROID BAROMETER. Stretch rubber from a toy balloon across the mouth of a small glass, and fasten it. Attach a short length of wire to the rubber with sealing wax, and connect the other end loosely to an indicating pointer, through a small hole. A scale for the pointer completes the instrument. To test it, place it in a large jar with a tightly sealed tube in the lid, as above. Blowing into the tube raises the pointer; sucking air out depresses it. Aneroid barometers use the same basic principle.

WHY BALLOONS RISE. Balloons go up because the hydrogen or helium gas that fills them is lighter than air. For the same reason, soap bubbles filled with hydrogen bob to the ceiling. You can generate hydrogen in a flask or bottle, containing scraps of zinc and a little dilute sulphuric or hydrochloric acid, and kept safely away from open flames. Attach a small pipe or a cone of paper to the delivery end of your hydrogen generator, and blow bubbles in a soap solution. Instead of falling, they rapidly ascend.

HOW A CAISSON WORKS. Invert a tumbler in a jar of water. Hold the tumbler against rising, while you blow air into it through a piece of tubing. The air displaces the water, showing how sandhogs can work in a caisson without getting wet. The inside of the "caisson" stays dry as long as the air pressure equals the pressure of water trying to get in.

How Water Is Purified

SIMPLE CHEMICAL REACTIONS GUARD HEALTH AND MACHINES

By KENNETH M. SWEZEY

BY MEANS of tests and chemical reactions easily duplicated at home, water chemists—the men who stand guard over the drinking and industrial water supply of the nation—make a unique contribution to the saving of human lives, materials, and machinery.

Water is one of the best solvents, and for that very reason really pure water never exists in nature. Even rain contains dust and gases. Springs and brooks run over rock and soil, picking up mineral compounds that give the water various degrees of hardness, and organic matter that colors it, gives it an odor, and too often serves as a breeding place for germs.

But with its simple tricks, chemistry changes this. Hard water is changed to soft; smells, color, sediment are removed; death is meted out to germs. Many municipalities and industrial establishments have elaborate water-conditioning plants and keep them under constant supervision of water chemists.

One of the commonest jobs is to remove suspended matter. Filtering through beds of sand and gravel helps accomplish this. But as too much sediment would clog the filters, most of the suspended particles are removed first by precipitation with alum, or aluminum sulphate.

You may demonstrate this with a glass of water containing a little soil and lime. A solution of alum poured in will precipitate white, gelatinous aluminum hydroxide. Stir the mixture, then allow it to stand, and in a short time the aluminum hydroxide will catch most of the suspended particles and carry them to the bottom.

If the water is naturally soft, this is followed by filtering through sand, gravel, and sometimes charcoal, the last of which removes color and odor. To show this, color some of the clear water from the last experiment with ink, and pass it through a filter funnel partly filled with powdered charcoal.

Water is hard when it contains salts of calcium, magnesium, and other metals that combine with soap to form an insoluble precipitate. Soap used alone must be in a quantity sufficient to precipitate these salts before it will lather, and therefore is a costly means of softening water.

Water containing bicarbonates of calcium and magnesium is called "temporary" hard water because limewater or boiling will remove them. The cause and cure of temporary hard water may be shown by a neat experiment. Stir a little calcium carbonate

Hard water needs extra soap, as shown below. In the bottles are, left to right, naturally soft water, water containing calcium sulphate, and hard water made soft with washing soda

River water is often made fit to drink by chemical and physical treatment. Add alum and lime solutions to a sample . . .

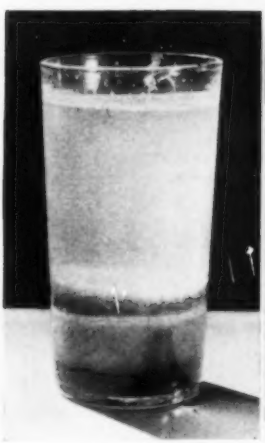
Specks of plaster of Paris will "permanently" harden water, but it can again be made soft by adding sodium carbonate. The chemical reaction produces calcium carbonate in a precipitate

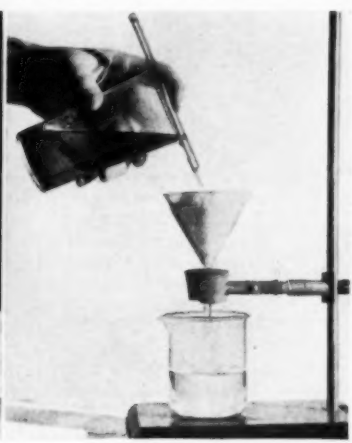
(precipitated chalk) into half a beaker of water and let it settle. Then generate carbon dioxide gas by pouring a dilute hydrochloric acid on marble chips in a flask. Lead the gas through a tube in the flask's stopper and let it bubble through the water. When you stir the water, the powdered chalk will disappear. The gas changes the carbonate into soluble bicarbonate.

To soften this water, boil it for 15 minutes, and then allow it to stand quietly. This drives out the carbon dioxide, changing the bicarbonate back to a carbonate which drops once more out of solution. The reaction may be caused by adding a little limewater. This time the lime, or calcium hydroxide, brings about the change.

"Permanent" hard water generally contains sulphates of calcium or magnesium, which are more difficult to remove. The most common method is to treat it with washing soda, soda ash, or crude sodium carbonate. Plaster of Paris is a form of calcium sulphate, and epsom salts is magnesium sulphate. Add a little of either to water in a test tube, and then add a little washing soda. The soda will change it to a precipitated carbonate. What remains in solution is sodium sulphate, which will not harm boilers or clothing.

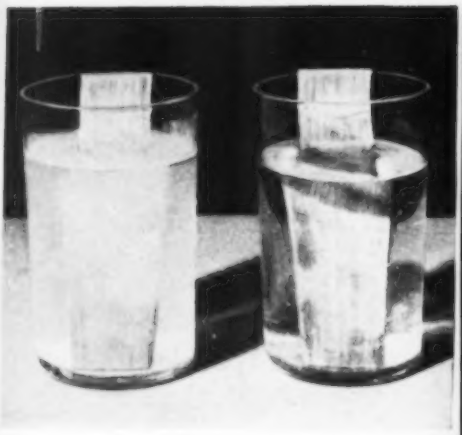
. . . the gelatinous precipitate formed will carry particles of dirt to the bottom. Then filter the top portion through sand, gravel, and charcoal, if all are necessary. The result is a crystal-clear water





In complete water-conditioning plants, river or lake water is first mixed mechanically with alum, lime, and sodium carbonate, which remove suspended matter and precipitate any salts that make water hard. The water is next filtered and led to a reservoir for treatment with chlorine gas to kill bacteria. Then as clean, soft, safe water, it goes to the consumer.

Chemists constantly test water under their care for the nature of its ingredients in order to know how to re-



Tap water has less action on lead than does a chemically pure water. Scrape the lead bright for tests. That shown at left above is with distilled water

Ordinary water contains air that will spoil many solutions by oxidation. To show the amount present in water, fill an apparatus like that at right full, and heat it. Air collects at the top

move the harmful ones. At home, begin by analyzing tap water in a test tube. Add a little ammonium chloride, ammonium hydroxide, and ammonium oxalate. Boil for a minute. A white precipitate indicates calcium in the form of calcium oxalate.

Now test for magnesium by filtering off the calcium oxalate, if any was precipitated, and adding to the filtrate a little more ammonium chloride and ammonium hydroxide. Add next a little sodium hydrogen phosphate, and shake the tube. The formation of a white crystalline precipitate—ammonium magnesium phosphate—indicates magnesium.

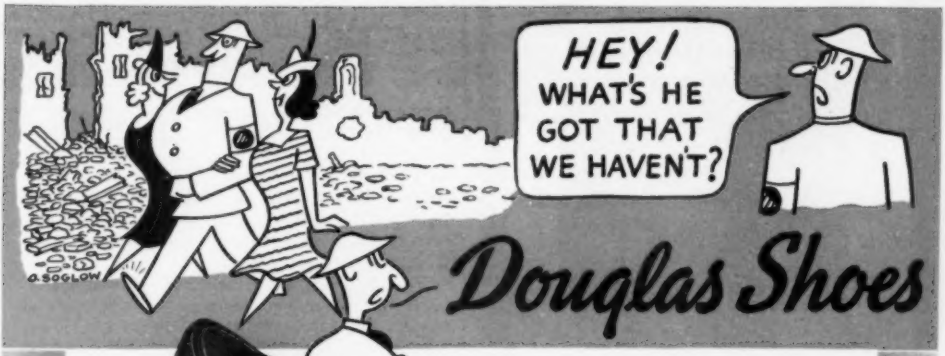
Iron may be present in the form of ferrous or ferric compounds. Add a few drops of hydrochloric acid and a little potassium *ferro*cyanide to a sample. A dark blue precipitate (Prussian blue) shows *ferric* salts. Add hydrochloric acid and potassium *ferri*cyanide, and a similar dark blue precipitate means iron in the *ferrous* form.

Lead, dissolved for instance from pipes, may be detected by adding hydrochloric acid and hydrogen sulphide to a sample. A black or brown coloration means lead.

Oddly enough, very pure water attacks lead more readily than ordinary tap water, which contains impurities. Scrape bright two pieces of lead, and put one in a glass containing distilled water and the other in a glass containing ordinary tap water. In an hour or so the distilled water will be milky from the lead it has dissolved, while the tap water will still be clear. If water lines are used constantly, the lead concentration from lead piping will never be harmful.

Air gives water most of its taste, and air causes most of the rusting action on metals and oxidizing of such substances as photographic developers. The large amount of air that is dissolved invisibly in water may be proved by gently heating tap water in a flask over which a test tube is inverted as shown in the photograph at right above. Fill both flask and test tube with water; the bent tube will permit some to flow out as heat expands it. Bubbles of air rise through and collect at the top of the tube. Water so heated has the flat taste of boiled water. The taste may be restored merely by whipping air in again with an egg-beater.

The presence of nitrates often indicates that water may be contaminated by animal refuse. Here is a test which is delicate to about ten parts nitric acid to a million parts water. To about half an inch of a water sample in a test tube add an equal amount of concentrated sulphuric acid and *cool*. Then, carefully and without mixing, add a strong solution of ferrous sulphate. The formation of a brown ring where the two liquids join indicates nitrates.



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Gus Brightens 'Em Up

(Continued from page 143)

tery and lamp bulbs. Then he quickly looked over the wiring of the lighting circuit. "Thought so," he said. "Loose connections here. Poor ground contact here. And Lord knows what other variations of grief will show up when we really get down to work on the job. Well, we can get around to all that in due time."

He went into the stockroom and came back with a relay which he installed in the upper-beam light circuit close to the headlamps, being careful to see that its base had a good electrical ground to the car frame. Then he installed a fuse holder and a 20-ampere fuse between the relay and the starting switch, and then used No. 12 gauge wire to make a lead from the battery terminal of the starting switch to the fuse holder and from the fuse holder to the relay.

"I don't get it at all," put in Wally.

"Well," Gus explained, "with the light switch closed for the upper beam, the relay closes a circuit direct from the battery to the headlamps. That takes the juice *around* the former lighting circuit, so the poor connections and other bad conditions in the circuit don't get a chance to cause a voltage drop. As a result, the lamp bulbs get the current they must have to operate at full efficiency. Get it now?"

"No," Wally said, "I don't."

"I'll explain it to you some other time," Gus said patiently. "Meanwhile we have to get these lamps refocused and aimed."

He moved the car onto the spot from which it was possible to adjust the lamps so that their beams would strike a wall marked to proper specifications of the right beam pattern. After he finished making the adjustments he looked up to see Jim Fraser standing there. "Well, I saw the eye doctor last night," Fraser said. "He sure gave me a going over. How's the car?"

Gus dispatched Wally for the brightness tester before replying, then turned to face his friend and customer.

"Wait two minutes, and I'll tell you," Gus said. Wally brought him the tester, and after he had put it on the lamps he grinned. Your headlights are as good as new," he told Fraser. "I mean that—I've brightened 'em up so that they give the same road illumination that they gave the day you bought your car. Give them enough care to keep them that way, Jim—it won't cost as much as buying specs would, and it'll keep you alive longer!"

"By golly!" Fraser exclaimed. "That's exactly what the eye doctor said."

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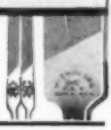

Inventions Can Win the War

(Continued from page 69)

shotgun principle in AA fire, parachute-supported explosives, floating air mines, freak types of projectiles, miniature submarines and mother ships for submarines, floating air bases, and, at the moment, rubber sources like the dandelion and other common plants.

On the positive side the independent inventor is advised to study newspaper and magazine photographs of military devices, or the actual equipment if he has access to it. Military literature and particularly military journals are valuable, both for information on what has been and is being done and to stimulate the mind to activity. Not only the current issues of military magazines should be consulted, but those of the past few years, in which a great many things were discussed which are now restricted. Often the best line on which to work is simplification or adaptation. Try to find a more efficient, easier, or quicker way of doing something which is already being done, rather than to discover brand-new things to do. The radio locator, for example, is an outgrowth of methods of geophysical explorations which have been in use for a long time. Instead of bouncing a sound wave off a subterranean rock layer, someone had the idea of bouncing a radio wave off an airplane. Most valuable inventions originate in this sort of analogical thinking.

Specific devices which would be valuable have been unofficially listed at various times. In the aeronautical field Dr. Jerome C. Hunsaker, professor at Massachusetts Institute of Technology and chairman of the NACA, has suggested a gas turbine to increase engine efficiency and reduce cooling and lubrication problems. The rocket plane is another suggestion from this source. The SAE Journal has published a list which includes hydrocarbon vapors as explosives; improved mobile landing-field floodlighting; better aircraft brakes; a lubrication system to keep an airplane engine well lubricated during dive operations; lighter hydraulic power equipment for aircraft; ice-prevention devices; mine-sweeping devices; AA bomb protection for cities, buildings, and ships; light armor and armored clothing; effective gasoline injection equipment in place of carburetor mixing; extraction and refining processes for utilization of low-grade ores. Alex Taub, an engineer familiar with both the military and industrial phases of war, advocates work on new coolants for aircraft engines; reduction in fuel consumption; im-

(Continued on page 222)

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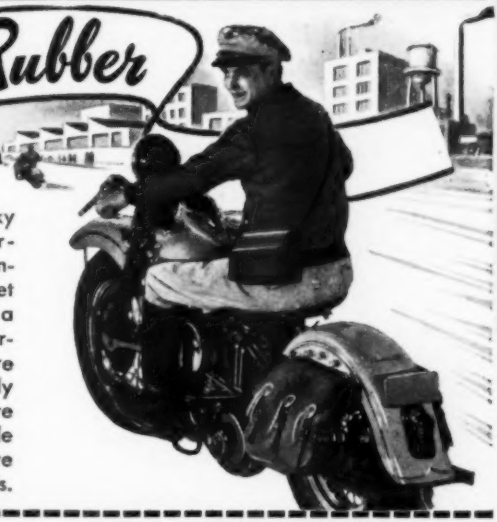

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Inventions Can Win the War

(Continued from page 220)

provements in superchargers; simple and easily serviced tank engines; tank transmissions to improve maneuverability.

For my part, I would advise the novice inventor to try to capitalize on his very lack of training, and to help others, and the country, by helping himself. In other words, don't aim high and wide. Look at what is close to you; there you can see the critical details.

This advice is particularly sound for the unskilled man who is actually working in war production. *The success of the war effort depends largely on utilizing unskilled labor to maximum advantage.* The unskilled, untrained man who has talent can help by thinking up ways of making things clear to himself, and therefore to a million others in the same boat. Even if only one in a thousand succeeds, we shall be that much nearer to winning the war.

As a specific example of what I have in mind, I would refer to a paper by Arthur E. Raymond, Engineering Vice President of the Douglas Aircraft Company, "Progress in Airplane Design during 1941," in the *Aeronautical Engineering Review* for May, 1942. Mr. Raymond describes how in the Douglas shops each separate operation in fabricating is now illustrated, not by blue prints which are abstract drawings requiring experience on the part of the user, but by marked photographs and easy-to-understand isometric sketches which tell the shopman what he is to do, and tell him clearly and quickly.

Here is an idea which is probably not patentable, which many would not regard as an invention at all. But who cares whether it is technically an invention or not? The one thing that counts is that it is helping to beat Hitler. I do not know whose idea it was—perhaps some high-powered engineer's. But it could have been a workman's contribution just as well. It did not take an M.I.T. degree; all it required was a healthy disrespect for tradition, and the initiative to ask why, when drawings were necessary, they could not be made up in a form which anyone with eyes and common sense could read.

It is by asking why, and formulating a straightforward, practical answer, that the vital problems of production are solved. The men who solve them will not gain immortality. They will merely have the consolation of having contributed to the sum total of humdrum, lowbrow invention which played a major part in the winning of the war.—CARL DREHER.

Our Planes Grow Stronger

(Continued from page 89)

which is unmistakably in the direction of larger calibers, both in machine guns and in cannon, as well as more of them. The Hurricane IIB has twelve .303 caliber machine guns. While such a multiplication of guns gives a shotgun effect and makes hits more likely, the damage may not be great unless a vital point is hit. The Hurricane IIC is armed with four 20-mm. cannon capable of firing 600 pounds of explosive shell per minute. It is said to have greater fire power than any other single-motor fighter. American fighters and bombers are provided with 37-mm. cannon and .30 and .50 caliber machine guns, the larger-caliber machine guns being favored for offensive action, with a few .30's held in reserve for defensive purposes on the way home. As fighter speeds increase, the superiority of the .50 caliber machine gun and cannon of 20-mm. size or larger becomes more pronounced. Since it is ordinarily possible to get in only a single burst, it might as well be a good one.

British experience in Libya has led to the conclusion that the bomb is not a suitable weapon for use against tanks. Neither bombs nor 20-mm. cannon proved effective against the German Mark 4's. At best, 20-mm. cannon could handle armored cars and light tanks. Tractor-mounted cannon firing 25-pound shells were effective against the heavy German tanks. Toward the end of the First World War, or shortly thereafter, the U. S. Army experimented with a 75-mm. cannon in an airplane and found no unsurmountable difficulties from recoil. It is practically certain that 75-mm. guns, or even larger, will fire from the air before the present war is over, but it may be found that a high-velocity gun of intermediate caliber, say 50-mm., is the best solution for the problem of tank destruction from airplanes.

Another probable development is the remote-controlled turret in bombers. Recently there have been reports in the English press of centralized fire control in planes equipped with power-driven turrets.

Theoretically there is no set limit to the amount of ordnance or cargo which a plane can carry, or the power of the engines which drive it. Glenn Martin already has plans for a commercial air vessel to weigh 125 tons, or roughly double the present maximum, to be followed by one weighing 250 tons. Grover Loening is talking of aircraft of 2,000 tons gross weight. Probably

(Continued on page 224)

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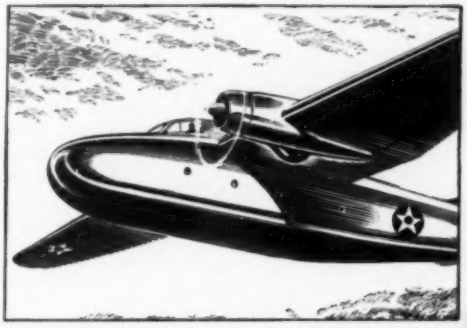

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Our Planes Grow Stronger

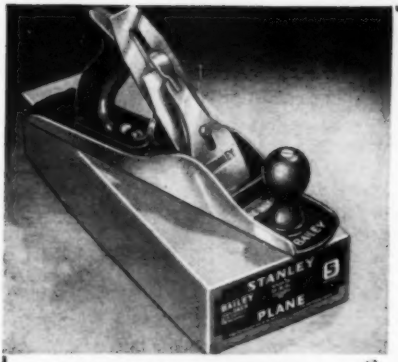
(Continued from page 223)

a 12-inch cannon especially designed for aircraft mounting could be built to weigh less than 100 tons. We can therefore conceive of an airplane carrying and firing a 12-inch gun some time in the future, although the idea is pure Buck Rogers phantasy as far as immediate prospects are concerned. But in one direction—that of speed—there is a definite limit unless a new aerodynamic theory can be evolved and practically applied. Speeds are going up and 500 m.p.h. appears attainable in the near future, but aside from the possible physiological limits of pilots, with existing types of airfoils there must be a halt not far beyond that point. As the speed of an aircraft approaches the speed of sound, which at sea level is roughly 770 m.p.h., the drag coefficient rises sharply to what would appear to be prohibitive heights. Moreover, compressive shocks are encountered which may cause uncontrollable flutter and make the craft unflyable even if it does not disintegrate under the stress. The air no longer flows evenly over the wing; instead there are abrupt changes in speed and pressure along the chord. These phenomena have already been experimentally verified in the wind tunnel.

As a preliminary to the solution of this problem, if indeed it can be solved, there will have to be a great deal of work in mathematical aerodynamics. Such investigation is already proceeding in connection with more immediate problems. David R. Davis and his collaborators are said to have devised a wing section for the B-24 Consolidated bomber which has resulted in a material increase in efficiency and combat power. Many other more or less novel aerodynamic designs are in use. On the one hand we have twin-tail airplanes like the Grumman Skyrocket, Lockheed Lightning, Fokker G1 and Focke-Wulf FW189. The engine nacelles of some of these are extended in the form of booms carrying the two tails, these being connected by a cross member.

Still another radical innovation which has reached the stage of flight-testing is the jet-propulsion airplane, which dispenses with a conventional propeller. Such a plane, built by Caproni-Campini, is said to have made a flight from Rome to Milan on November 30, 1941. According to the descriptions which have appeared in the airplane journals, this plane is equipped with a large duct running the length of the

(Continued on page 226)



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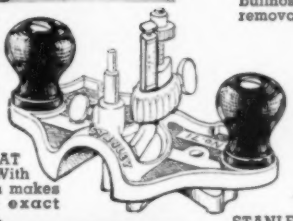

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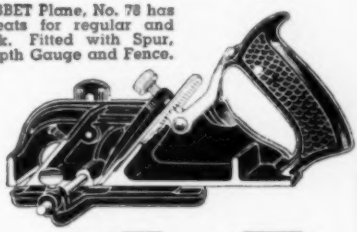
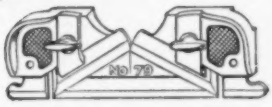


STANLEY SIDE RABBET Plane No. 79. Both right and left hand, for side rabbeting in trimming dadoes, mouldings and grooves.



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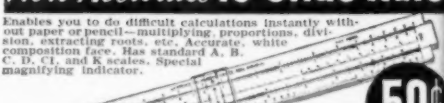

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(Continued from page 224)

fuselage. The engine drives a blower which impels the air toward the tail. There it is joined by the hot exhaust gases and ejected through exit nozzles, producing the thrust which drives the plane forward. Essentially such an aircraft is one in which the propeller is located inside instead of outside the fuselage. Under these conditions an impeller blade may be designed to operate at higher efficiency than an outside propeller blade.

Jet propulsion is not the same as rocket reaction, the latter being effective in vacuum, whereas the former depends on the collision between the ejected gas and air and the outside air. Jet reaction depends on a continuous volume of discharge at comparatively low speeds of discharge; rocket reaction is explosive in character and designed for flying in interplanetary space rather than in the earth's atmosphere. According to one report, however, the Germans have made use of rockets for assisted take-off of heavily loaded aircraft. This is a possible application of the rocket-reaction principle which may assume military and commercial importance in the near future, especially in view of increasing loads.

The aeronautical developments which are thus coming to a head—real mass production of planes, the conquest of speed and altitude, the steady growth of motor power and efficiency, the building of freighter planes and the establishment of air cargo routes as part of the war effort, increases in fire power and bomb loading, innovations in aerodynamic design, all foreshadow the expected postwar boom in aviation.

For postwar exploitation the most promising is cargo carrying by air. Here we see graphically the interaction of military and civil applications which characterizes modern technological progress. Before the war American air lines, flying 150,000,000 miles a year on domestic and international routes, were a proving ground for ideas and designs which were later incorporated in military practice. During the last few years the Army has carried more cargo by air than all the air lines of the United States combined, and under the spur of necessity it is expanding its cargo-carrying activities on an enormous scale. With the experience which is now being gained, the military services and civilian designers now busy on military problems will be in a position to repay all their debts to civilian flying and to throw in a handsome bonus of new designs, devices, and know-how.

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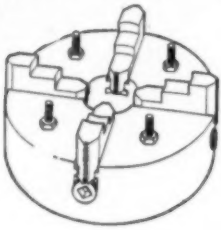
Tape Reinforces Model Coupler

On model railway cars equipped with remote-control uncoupling of the type shown, the cars sometimes uncouple of their own accord when they pass over switches and the uncoupling contacts touch the middle rail. This trouble is readily corrected by placing one or two layers of narrow strips of cellulose tape along the edges of the contacts, leaving the center uncovered. The strips keep the contact shoes from touching the rails on the switches, yet allow the uncoupling device to work on the special five-rail track section.—C. E. B.

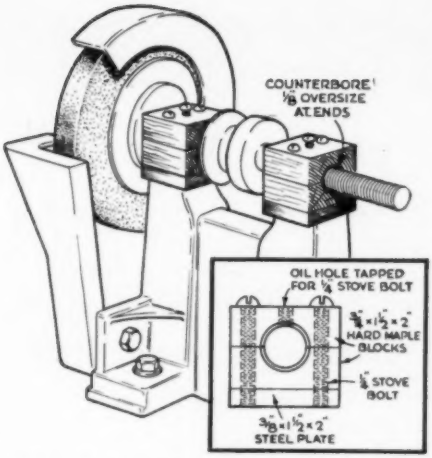
Studs in Chuck Hold Work True



It is often necessary to chuck lathe work so that a previously machined surface facing the chuck runs dead true. Since the faces of chuck jaws are rarely true enough, one way to attain precision is to drill and tap the chuck body between the jaws for four short studs as shown in the drawing. Run locking nuts on, screw the studs in to project a little more than the corresponding steps of the chuck jaws, and tighten the lock nuts against the chuck face. It is the work of a moment to face the projecting bolt ends true, after which the work is chucked to bear against them.

Several sets of tapped holes may be provided for different diameters of work. The studs can quickly be faced true again if it is necesary to reset or remove them.

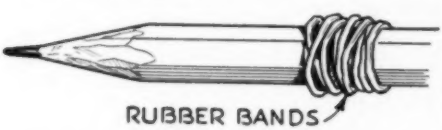
Do not drill a geared or universal chuck until certain you will not damage the mechanism that moves the jaws.—J. S. Morrel.



Maple Blocks Form Bearings for High-Speed Grinder

HARDWOOD bearings, long used on heavy-duty line shafts, can be employed elsewhere in the shop when metal proves hard to obtain. Having had trouble with the original bearings of a power grinder, I sawed off the housings and welded in their place two flat steel plates ⅜" by 1½" by 2", in each of which I drilled and tapped two holes, as shown above.

Each bearing was made of two maple blocks, which were drilled for the assembly bolts. With these in place, the shaft hole was first bored ¼" deep from each side with a bit ⅛" oversize, then bored through to the shaft size. The recesses so formed prevent the bearing from throwing oil. I soaked the blocks in oil before assembly, and made them a close fit for the shaft by sanding the joining surfaces slightly. To date these bearings have given excellent service for one year and show very little wear.—RALPH S. WILKES.



Retaining Pencil in Pocket

TO AVOID losing your pencil from an overall pocket every time you bend over, wrap two or three rubber bands around the middle of it. They cannot harm the fabric, do not make the pencil hard to replace in the pocket, nor interfere with its use as a cord does.—CHARLES H. HARDY.

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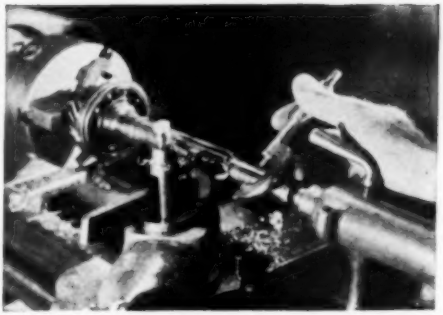

Junked Auto Shafts Provide Stock for Making Tools

AS STEEL becomes increasingly difficult to obtain, more and more thought is being given to the use of old auto parts as a source of this material. However, although there is a large amount of steel in a car, there are actually few parts that can be reused to advantage in the small shop. Drive shafts, axles, transmission and steering-gear shafts are the main parts that will serve in place of steel stock. There are very few flats large enough to be of value, and as there are even fewer hardened parts, very little high-carbon steel is available.

Axles as a rule contain from .6 to .9 percent manganese, 1 to 1½ percent nickel, and .6 to .9 percent carbon. These make excellent arbors or mandrels and can also be used in place of cold-rolled stock. Transmission and steering-gear shafts are about the equivalent of S.A.E. 10/20 steel and can be made up into end mills and other cutting tools, which should serve quite satisfactorily in the average shop if casehardened.

Good casehardening requires a furnace and other equipment, and it takes from 3 to 24 hours of red heat for carbon to penetrate the steel to a depth of 1/32" to ⅛". After this carburizing process is complete, the steel must be reheated and quenched in water to harden the outer casing. Full instructions for this process can be found in most shop handbooks.

Small articles subject to wear can be casehardened by the cyanide process, which is much simpler. The steel parts are heated red-hot and covered with a thin layer of commercial powdered potassium cyanide (poison), which should be allowed to melt and "soak in," after which the parts are again heated red-hot and dropped into cold water.

If a colored, mottled effect is desired, this can be obtained by first polishing the steel parts bright, heating them red-hot, and covering with cyanide as before; then quench-

ing in water in which air bubbles are rising to the surface. The bubbles can be produced by blowing into a tube placed in the water. The air tends to color and mottle the surface as it is being hardened. Some workers add to the quenching bath 2 oz. of potassium nitrate, 1 oz. each of machine oil and kerosene, and ½ oz. of acetone per quart of water. *Great care should be exercised in using cyanide of potassium as it is a deadly poison.* The fumes should not be inhaled.

It is practically impossible to secure from automobile manufacturers the analysis of the steel used in various parts of the car and motor, but with a little study the mechanic can determine the carbon or alloy content of the material by spark testing. The grinding wheel should not be in bright sunlight nor in total darkness; a soft, diffused light will be found best. The higher the speed, the larger and stronger the spark stream and the less pressure needed. Use only enough pressure to maintain steady contact with the wheel.—C. W. WOODSON.

Aligning Drill on Round Work

AN EASY way to drill holes precisely on the diameter of round bar stock is shown in the photograph at left. Cut a thin disk from the end of the bar, chuck it in the lathe to run dead true, face it smooth, and centerdrill it to the same size the hole in the work is to be. Clamp the disk and the work together in the drill-press vise, as shown. The hole in the disk will spot the drill exactly on the center line of the work, and also prevent drifting while the hole is being drilled.

Screw and Wire Form Eyebolt

MAKING wing nuts from ordinary screws by soldering a piece of sheet metal in the slot is a familiar trick. Another handy stunt to remember is that neat eyebolts can be made quickly by soldering a ring of stiff wire into the slot of a roundhead screw. The slot should be widened with a file until the wire just fits in tightly to insure a strong soldered joint.

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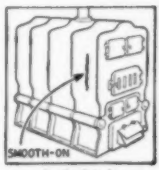

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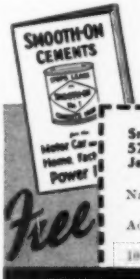

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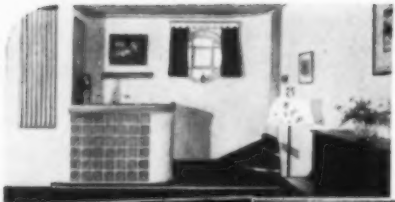

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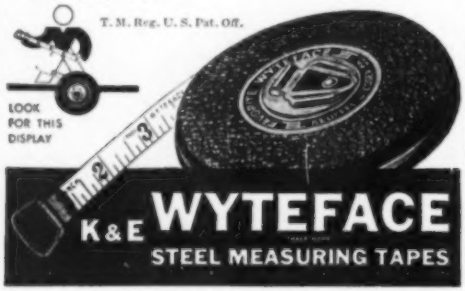

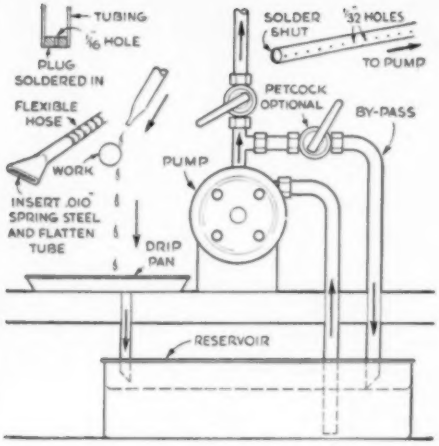

Auto Pump Floods Lathe Work with Cutting Lubricant

AN OLD automobile oil pump is excellent for circulating cutting fluid or coolant over work in a lathe, shaper, or milling machine. Tools stay sharp longer and cuts are smoother when such fluids are used. As the pump will circulate the same liquid again and again, it holds cost to a minimum.

One such pump from a popular light car was bolted to a lathe bench, fitted with a pulley in place of the gear that had been on the shaft, and driven by a 1/6-h.p. motor at a speed reduction of 1 to 3. As it delivered far more fluid than was needed, a by-pass tube was run back from the pump to the reservoir, and a petcock was installed in the delivery tube for positive control of the flow over the work.

This pump had a third opening to which the by-pass tube was connected; on pumps having only an intake and a delivery opening, solder the by-pass into the delivery tube between the petcock and the pump, as shown in the drawing. For further control of the flow, a second petcock may be inserted in the by-pass line as shown above.

A shallow baking tin or similar utensil will serve as a drip pan. Solder the outlet tube to the bottom and a piece of wire mesh across the top. Clip a piece of cloth over this to strain out chips. The reservoir may be a can or bucket of almost any kind, but should be relatively deep so that any chips passing into the system will settle out. The intake tube should not reach closer than ½" to the bottom.

Old automobile tubing and fittings will do for all piping and connections. Nozzles can be made as shown.—J. F. HYLAND.

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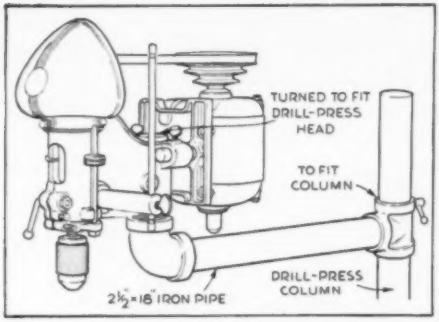


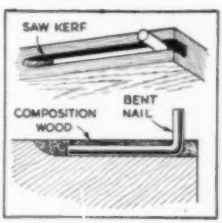
Pipe Parts Used to Increase Capacity of Drill Press

A RADIAL extension from its vertical column may increase the capacity of your drill press by as much as three times, so far as the size of the work is concerned.

The drawing above shows an extension built for a drill press having a 2¾" column. Select a cast-iron pipe tee of proper size and bore it to a sliding fit on the column. Drill and tap a ½" hole for a bolt to clamp the tee. Screw an 18" length of pipe in the branch opening and put a 90-deg. elbow on the outer end. Make sure that when both screw connections are tight the elbow will line up with the column. Turn down an 8" long pipe nipple to the column diameter, leaving sufficient threads on one end to engage those in the elbow, and mount the head of the drill press on this.

The extended assembly can be used with the bench or floor as a table, or two angle irons can be clamped to the original drill-press table and a piece of steel or wood placed across them.—FRANK J. SORENSEN.

Nail Forms Neat Pin Hinge for Thin Cabinet Door



IN FITTING thin doors to a small sewing cabinet, I found that hinge pins split the wood even though holes were drilled for them. Finally I ran a 3/16" deep saw kerf in the edge at each hinge corner, as shown. A pin made by cutting off and bending a fivepenny box nail fitted this snugly. Plastic composition wood filled the rest of the kerf and helped hold the pin in place.—MARC M. SAUNDERS.

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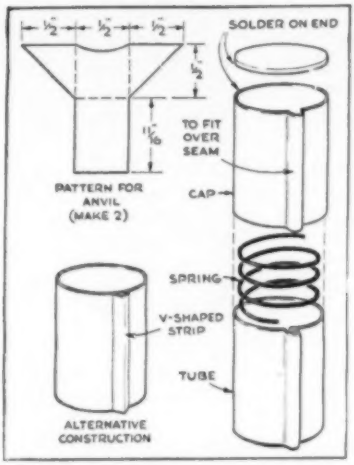

Ash Tray Made from Tin Plate Has Built-In Snuffer

AN ASH tray with a built-in cigarette snuffer that can be made from salvaged tin plate is shown in the photograph below. The snuffer can also be attached to a purchased ash tray or to one of the builder's own design. A domed bottom from a beverage can forms the individual one illustrated. To it was soldered a hollow tube rolled up from tin plate. The original had an interlocking seam, but a lap seam will do if a piece of thick iron wire or a V-shaped strip of tin plate is soldered over it as shown in the drawing above.

A similar but shorter tube serves for the cap. In it a groove is shaped to fit over the seam of the other, which will keep the two anvils aligned. These are soldered on the tube and cap to meet when the latter is depressed. The spring from an old electric-iron plug is inserted and soldered to the bottom edge of the tube before it is attached to the base, and to the inside of the cap before the end is soldered in place on it.—EDWARD KIEHL.

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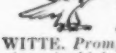

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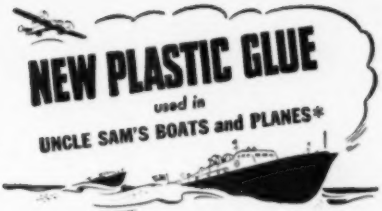

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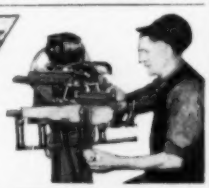

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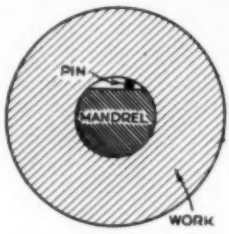
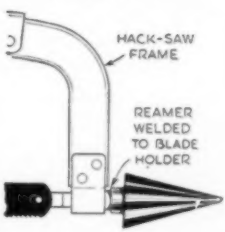


IT IS sometimes undesirable to force small or fragile work on a mandrel because of the danger of breaking or distorting it. One solution is to use a mandrel that is a free push fit. Mill or file a flat in the part on which the work is to go, taking care to make it parallel to the axis.

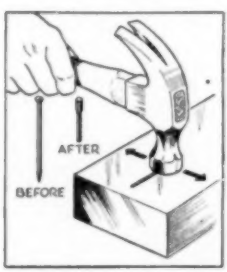
Insert a round pin as long as the bore of the work and of a diameter to fit freely in the opening. A piece of nail or wire will do. A slight turn of the work in either direction locks it securely enough for machining, yet it can be freed instantly by a light jerk in the opposite direction. A set of such mandrels in the most frequently used sizes, or a stepped mandrel with such flats milled on the several diameters, will prove a time saver.—J. S. MORREL.

Reamer Welded to Hack Saw Removes Burr in Conduit

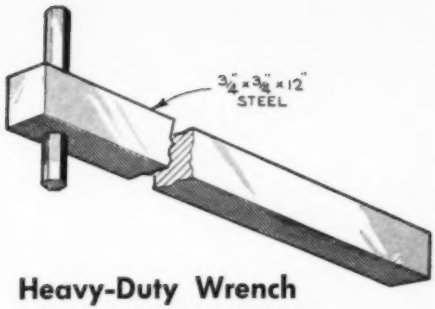


SHORT circuits sometimes result from failure to ream the burr out of conduit after it has been sawed to length, especially if the conduit is crowded with wire. By welding a reamer onto the hack saw, as shown, you have a double-purpose tool that makes it easy to ream conduit after it is sawed.—RANDOLPH DE FREITAS.

Belaying Pins for Small Ship Models



MODEL belaying pins can be made from common pins as at the left. Lay one on an anvil or steel plate and roll it back and forth with increasing pressure under the head of a hammer. Cut to length, and file the ends smooth.

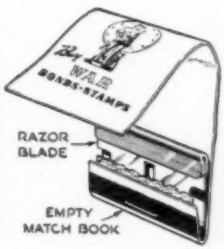


Heavy-Duty Wrench Removes Corroded Setscrews

MORE leverage for removing safety setscrews that have become corroded in their holes can be obtained by providing a stout handle for the setscrew wrench. Near the end of a steel bar of suitable size, drill a hole the dimension of the small diameter of the wrench. Grind a piece of the wrench square at one end and force it through, thus broaching the hole in the bar into a hexagon and obtaining a tight fit.—R. H. MCNAIR.

Safety-Razor Blade Can't Harm If Carried in a Match Cover

A MODEL builder can pocket his ever-handy safety-razor blade without danger of nicking a finger by inclosing it in a cover from which paper matches have been torn. Put the blade, sharp edge down, behind the stub left from the matches.—H. O'C.



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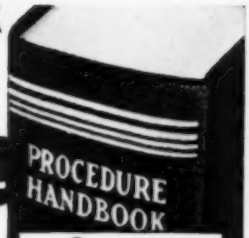

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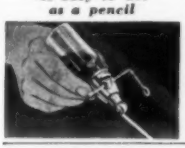

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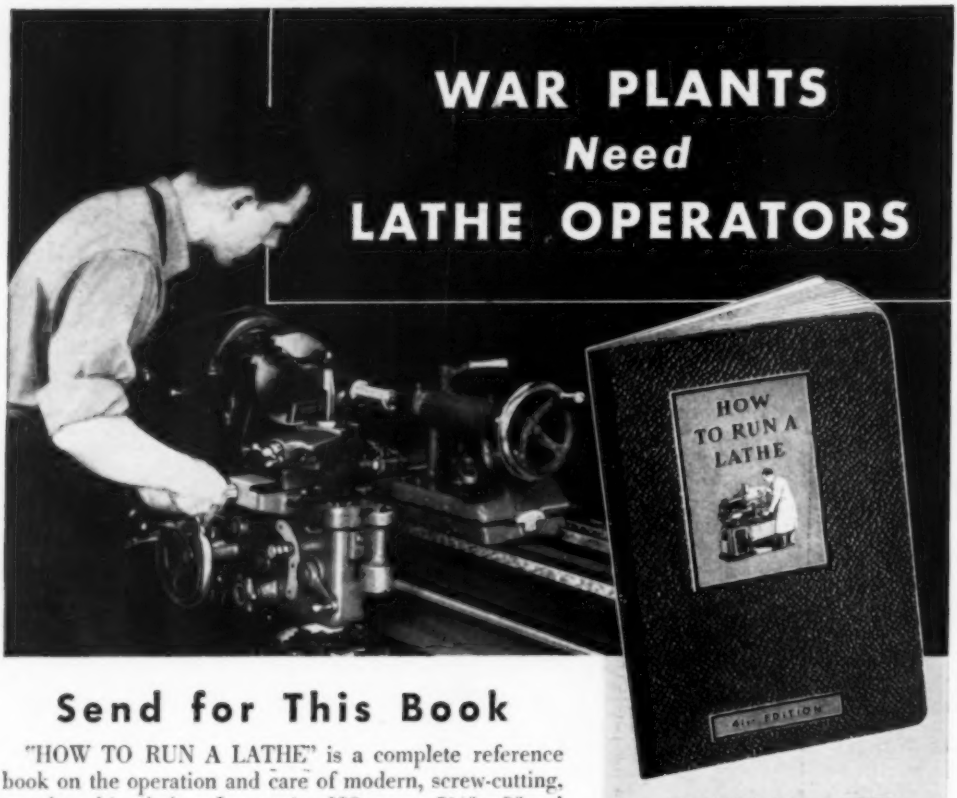

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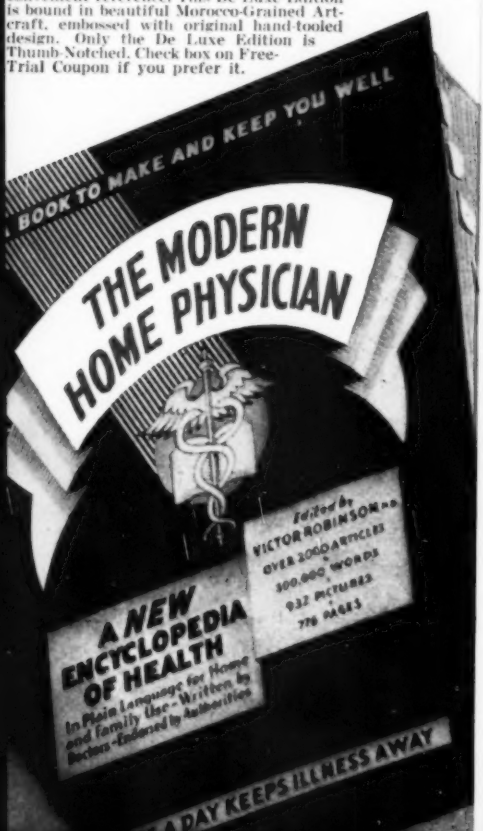
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